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COMPLETE NOTES

For Hamromaster Online Classes

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size
appearance
frequency
inter catching
size
after
frequency
inter catching

4 Sampling

[Generally one question is asked from this chapter i.e. theory or numerical]

Important formula for numerical problems

Determination of sample size in Research.

i. **For Quantitative variables**

$$n_0 = \frac{t_{\alpha/2}^2 \, \sigma^2}{d^2}$$

Then to estimate 'n' by using relation

$$n = \frac{n_0}{1 + \frac{n_0}{N}}$$

where, σ = population standard deviation

$t_{\alpha/1}$ = critical value for two tail test at α level of significance

d = desired error in estimation of the population mean = $\overline{X} - \mu$

But, for large population, $N \to \infty$

then $\frac{n_0}{N} \to 0$

Then it becomes,

$n = n_0$

ii. **For attribute with two possible outcomes**

$$n_0 = \frac{t_{\alpha/2}^2 \, PQ}{d^2}$$

where, P = the proportion of an outcome of 0 dichotomous attribute in the population.

$Q = 1 - P$

iii. **For sample size based on C.V.**

$$n_0 = \frac{t_{\alpha/2}^2 \, (cv)^2}{p^2}$$

Where, cv = coefficient of variation

p = % of error in estimation of sample mean

Confidence limit

- Sometimes on the basis of sample mean observed, the limits of the value of unknown population mean arc to be predicted. The limits are called confidence limits.

- The range of the limits is called confidence interval and the estimation done is called interval estimation.

$$C.L. = \overline{X} \pm t_{\alpha/2} \, S.E.$$

where, $\overline{X}$ = mean

C.L. = confidence limit

$$S.E. = \frac{\sigma}{\sqrt{n}} = \text{standard error}$$

1. **Give the comprehensive meaning of a sample, sampling and their objectives. What are the steps to be followed in sampling? Also discuss the context in which a population & sampling units are defined.**

[TU 2062]

Solution:

Sample

A selection taken from a large group (the population) so that it can be examined to find out something about the large group is generally considered to be sample. In many cases it is practically not possible to include all units of the populations for investigations. Therefore s few of the population units have to be selected as a representative of the whole population. The few selected units / a part of the population is called sample. However two conditions are to be fulfilled for these few selected units to be a sample. The conditions are:

- Each and every unit of the population must have non-zero probabilities for their inclusion in the sample selected.

- The selection must be done according to accepted statistical procedure also known as sampling technique.

Sampling

- Sampling is the process of obtaining data/information about an entire population by examining only a part of it. It is simply understood as the process through which sample is drawn from entire population. In drawing samples, the following three criteria are to be considered.
- Purpose of the investigation
- Types of the sampling/sampling design to be used.
- Size of the sample at each stage sampling.

Objectives

- To produce results at a relatively faster speed
- To obtain information when population contain infinitely many members and census is impossible.
- To economize money, time and effort.
- To obtain information of some characteristic of the population by estimating the sampling errors.
- To make more logical when all the units of a domain are alike.

The steps to be followed in sampling

- Defining the population to be covered.
- Defining sampling units
- Acquiring frame/list of the population elements.
- Deciding about the size of the sample
- Deciding about the type of the sample to be used.
- Testing the reliability of the sample

Population: According to Kish, a population has to be defined in conjunction with the purpose of the study. Population is defined in terms of:

Content (for example: all persons)

Units (for example: family units)

Extend (for example: the area covered)

Time (for example: the calendar year)

Sampling units:-

The population units selected in simple is called sampling units. Types of sampling units dealt in socio-economic survey are:

- Geographical units: ecological regions, Districts, Cities, wards, etc.

- Structural units: A house, a flat etc.
- Social group units: A family, a school, a club etc.
- Individuals

2. **What is sampling? Discuss its importance in a research work.**

[TU 076]

OR

What is sample random sampling? Describe methods of selecting sample with replacement and without replacement in SRS with example. [TU 075]

OR

Explain why sampling is so important in research. Discuss different types of sampling. [TU 056]

OR

Explain why sampling is important in research work. Discuss in brief probability sampling. [071]

Solution:

For the population consisting of a number of units, usually very large and sometimes infinitely many, it is practically not possible to include all units of the population for investigation. Therefore a few of the population units have to be selected as a representative of the whole population. The few selected units of the population are called the sample and the technique of drawing sample is called sampling. The sample should be truly representative of population characteristics without any bias so that it may result in valid and reliable conclusions.

Sampling is used in practice for a variety of importance such as:

- Sampling can save time, money & effort.

- Sampling may enable more accuracy measurement for a sample study as it is generally conducted by trained and experienced investigators.

- It produces results at a relatively faster speed than a census method.

- Sampling remains the only way when population contains infinitely many members.

- Sampling remains the only choice when a test involves the destruction of the item under study.

- It estimates the sampling errors and helps in obtaining the information concerning some characteristics of the population.

- Sampling becomes more logical when all the units of a domain are alike.

For these reasons, sampling is so important in research.

Types of Sampling

There are several methods of selecting population units to be included in the sample on the basis of probability. The techniques of selecting a sample are classified as- non-probability sampling and probability sampling. But in non-probability samplings, The probabilities of population units to be included in the sample are not considered, they are not sampling in statistical sense. Therefore, they cannot be used for statistical inferences.

Generally, these are classified as

a) Non-random sampling / Non-probability sampling.

b) Random sampling / probability sampling.

a) **Non-random sampling**

This technique consists of the following methods:

(i) **Purposive sampling**

In this method, the researcher deliberately or purposively selects certain units for study from the population. The choice of the selection is supreme and nothing is left to chance. The particular units of the universe for constituting a sample on the basis that the small mass that they so select out of a huge one will be typical or representative of the whole. For instance, if economic conditions of people living in a state are to be studied, a few town and village may be purposively selected for intensive study on the principle that they can be representative of the entire state. Thus, the judgment of the organizers of the study plays an important role in the sampling design.

The defects of the methods are:

- The knowledge of the population must be available, which in most cases is not possible.
- The controls are not effective and, often a biased sample is selected.
- Errors of sampling rest upon hypotheses which are seldom met in practice.

But some merits of the method are:

- If proper care is taken in selecting the sample to keep out any bias, the sample may represent of the population.
- The method is very cheap.
- It is more useful specially when some of the units are very important and must be included.

(ii) Quota sampling

This is considered to be special is form of stratified sampling. According to this method, the population is first divided into different strata. Then the number of units to be selected from each stratum is decided. This number is known as quota. The field workers are generally asked to select the quota from the stratum according to their conveniences.

Example: Opinion surveys are mostly conducted by using this method.

(iii) Convenience sampling

In this method, a sample is selected taking convenience of the sample into consideration. The convenience may be in respect of availability of source list, accessibility of the units etc.

Although the method is most unscientific yet a quite a large number of sample are selected according to this method. The method is to be used when:

> The population is not clearly defined.

> Sampling units are not clear.

> A complete source list is not available.

Example: The selection source list is not from telephone directory will come under this type of sampling.

(iv) Self – selected sample

Sometimes a sample is not actually selected but people themselves come for inclusions in the sample.

For example, an enquiry has to be made about the people's linking about a particular TV program and announcement to this effect is made on TV/Radio. Newspapers In such enquiry the sample is not fixed. Those who care to reply form a part of the samples. Such a sample is called self selected sample.

v. Snowball sampling

It is a non–probability sampling technique where existing study subjects recruit future subjects from among their acquaintances.

It uses a small pool of initial informants to nominate, through their social networks, other participants who meet the eligibility criteria and could potentially contribute to a specific study. The term 'snowball sampling' reflects an analogy to a snowball increasing in size as it rolls downhill.

Snowball sampling is a method used to obtain research and knowledge, from extended associations, through previous acquaintances. Snowball

sampling uses recommendations to find people with the specific range of skills that has been determined as being useful.

An individual or a group receives information from different places through a mutual intermediary. This is referred to metaphorically as snowball sampling because as more relationships are built through mutual association, more connections can be made through those new relationships and a plethora of information can be shared and collected, much like snowball that rolls and increase in size as it collects more snow. Snowball sampling is a useful tool for building networks and increasing the number of participants. However, the success of this technique depends greatly on the initial contact and connections made, thus it is important to correlate with those that are popular and honorable to create more opportunities to grow, but also to create a credible and dependable reputation.

Merits
- It is used to locate hidden populations.
- It can be used in locating people of a specific population.

Demerits
- Community bias
- Not Random
- Vague overall sampling size
- Wrong anchoring

b) Random Sampling

Random sampling is also called probability sampling since the selection of the units is not arbitrary and each unit of the population has certain chance (probability) of being included in the sample. This type of sampling has to be used to make inference of the study valid and reliable.

(i) Simple Random Sampling

It refers to that method of sample selection in which each and every units of the population is given calculable non-zero equal probabilities of inclusions in the samples of size of in: There are two approaches of this method

Simple Random sampling with replacement or un restricted sampling simple Random sampling without replacement or simply simple random sampling.

In the first method, once an item selected for the sample is returned to the population before the next item is selected. In such a situations, the some element could appear in successive selection

In the second case, the units selected once are not replaced i.e. once on item is selected for the sample it cannot appear in the sample again.

In brief, the implications of simple random sampling are:

- It gives each element in the population an equal probability of getting into the sample and all choices are independent of one another.

- It gives each possible sample combination an equal probability of being chosen.

(ii) Restricted Random Sampling

Sometimes samples are drawn by using some restrictions on the selection procedures of population elements. The restrictions are made usually on the elements of the population unlike in simple random sampling technique.

In other words, the elements are not provided equal chance of being selected in the sample. Some of these types of samples are:

(a) Stratified sampling

In this method, first of all the population is divided into a number of groups called strata care is taken to make the elements within a group as homogenous as possible. Then, at least heterogeneous more possible than at, least one element from each group is selected and the estimates of population parameters are made.

(b) Cluster sampling

Sometimes, a population unit may comprise of more than one element called clusters. In this sampling, the total population is divided into a number of relatively small subdivisions which are themselves clusters of still smaller units and then some of these clusters are randomly selected for inclusions in the overall sample.

> **Example:** suppose, we want to estimate the proportion of machine parts in inventory which are defective. Also assume that there are 20,000 machine parts in the inventory at a given point of time, stored in 400 cases of so each. Now, using a cluster sampling, we would consider the 400 cases as clusters and randomly select 'n' cases and examine all the machine parts in each randomly selected case.

c. Multi-stage sampling

In this method the samples are taken in different stages. Firstly, the sample is taken at random from the population in large size. The sample taken firstly is again sampled to get a small unit of sample which can further

be sampled to get still smaller unit of sample the sampled to get still smaller unit of sample. The process of sampling is repeated till we get the required sample. For example. We want to have the literate people of villages. Firstly, we select the literate people from some of the Anchals into different districts. A sample of literate people from some of the districts be selected. Further we divided these districts into different villages. A sample from some of the village be selected which is the final sample.

Merits:

- This method of sampling is more flexible in comparison to other method.

- This method is simple to carry out.

- Since the sample size reduces each time, it saves time, cost and labour.

- This method is the most convenient one when the area of investigation is vast.

Demerits

- This method may give faulty result if samples different stages are not taken carefully.

- In general, this method is less accurate than a sample of same size which has been selected of size which has been selected by some suitable single stage method.

3. **Determine the minimum sample size required so that the sample estimate lies within 5% of the true value with 99% level of confidence when coefficient of variation is 40%.** [TU 075]

Ans: *For simple random sampling, See Q.no. 2*

$\alpha = 1\%$

Numerical

Solution:

$t_{\frac{\alpha}{2}}$

Coefficient of variation (C.V.) = 40% = 0.4

P = 5% = 0.05

For $\alpha = 1\%$ (level of confidence = 99%)

$t_{\alpha/2}$ [t-value for two tailed test at 1 % level of significance]
= 2.576

We have,

Sample size (n_0) $= \dfrac{t^2_{\alpha/2} (c.v.)^2}{p^2} = \dfrac{2.576^2 \times 0.4^2}{0.05^2}$

∴ Sample size (n_0) = 424.96 ≈ 425

4. Define sampling and explain the characteristics of a good sample. Discuss its advantages. Determine the sample size required so that mean of the sample estimate lies within 5% of the true value with the level of confidence 0.95, when coefficient of variation is 30%.

[TU 073]

Solution:

For sampling & characteristics, See Q.No. 1

Advantages of sampling See Q.No. 2

Numerical:

Given,

$$C.V. = 30\% = 0.30$$

$$P = 5\% = 0.05$$

For α = 5%, (level of confidence = 0.95 means its 5% level of significance.)

$$t_{\alpha/2} = 1.96$$

We have,

$$n_o = \frac{t_{\alpha/2}^2 (CV)^2}{p^2} = \frac{1.96^2 \times 0.3^2}{0.05^2} = 138.2976$$

$\therefore$ Sample size (n_o) = 138.3

5. What is non probability sampling? Describe the conditions under which the non probability sampling is preferred? Elucidate the differences in i) convenience sampling and purposive sampling ii) snowball sampling and quota sampling.

[TU 074]

Solution:

See Q.No. 2

6. What is sampling? What are the steps to be followed in sampling? also discuss the context in which a population and sampling units are defined. Describe the technique of testing the reliability of the sample chosen.

[TU 061]

Solution:

For the sampling, step and different context in which a population and sampling units are defined, see Q No. 1.

Technique of testing the reliability of the sample chosen.

While testing the reliability of the sample, the size of the sample is an important factor to be considered. This is because the size has a direct bearing upon accuracy of estimation, cost and administration of the survey. Though large samples give smaller standard errors, they are generally difficult to manage and unfit for detail study, on the other hand, small samples tend to give higher standard errors but avoid unnecessary expenses.

Therefore, an optimum sample size is required. An optimum sample size is one which fulfills the requirements of efficiency. Representativeness, reliability and flexibility.

If the sample design is simple Random sampling, the simple procedure is first to estimate.

$$n_0 = \frac{t^2_{\alpha/2} \, \sigma^2}{d^2}$$

Then to estimate 'n' by using the relation

$$n = \frac{n_0}{1 + \frac{n_0}{N}}$$

Where,

σ = population standard deviation

$t_{\alpha/2}$ = critical value for two tail test at α level of significance.

d = Described error in estimation of the population mean = $\overline{X} - \mu$

since $n_0 > n_1$ higher so sample size i.e. no is better than smaller one i.e. n_1.

for attributes with two possible outcome it can be shown that $\sigma^2 = PQ$. Then the relation takes the form

$$n_0 = \frac{t^2_{\alpha/2} \, PQ}{d^2}$$

Where P = the proportion of an outcome of a dichotomous attribute in the population.

$$Q = 1 - P$$

7. The mean systolic blood pressure of a certain group of people was found to be 125 mm of Hg with standard deviation of 15 mm of Hg. Calculate sample size to verify the result at 5% level of significance if error does not exceed 2. Also find sample size if sample is selected from population of size 500.

Solution:

Standard deviation $(\sigma) = 15$

$$\alpha = 5\%$$

Error of estimation $(d) = 2$

Sample size $(n) = ?$

We have,

$$n_0 = \frac{t_{\alpha/2}^2 \; s^2}{d^2}$$

$$= \frac{15^2 \times 1.96^2}{2^2}$$

$$= 216.09 \approx 216$$

When, $N = 500$

$$\text{Sample Size } (n) = \frac{n_0}{1 + \frac{n_0}{N}} = \frac{216}{1 + \frac{216}{500}} = 150.83 \approx 151$$

8. In measuring reaction time, a psychologist estimates that the standard deviation is 0.05 seconds. How large a sample of measurement must be taken in order to be 99% confident that the error of his estimate will not exceed 0.01 seconds?

Solutions:

Standard deviation $(\sigma) = 0.05$

Confidence level $= 99\%$

$t_{\alpha/2}$ at 99% level of confidence $= 2.58$

(i.e. 1% level of significance)

desired error of estimation $(d) = 0.01$

Sample size $(n) = ?$

We have

$$n = \frac{t_{\alpha/2}^2 \; \sigma^2}{d^2}$$

$$= \frac{2.58^2 \times 0.05^2}{0.01^2}$$

$$= 6.6564 \times 25 = 166.4 \approx 167$$

Hence, the sample size of measurement to be taken is 167.

9. **What are the factors affecting sample size? Explain.**

OR

Discuss about the factors affecting sample size.

Solution:
We know, sample size is determined by using formula

$$n = \frac{t_{\alpha/2}^2 \, \sigma^2}{d^2}$$

Three factors are used in the sample size calculation and thus, determine the sample size for simple random sample.

These factors are

1) Margin of error
2) Confidence level
3) Proportion (or percentage)

i) **Margin of error**
It measures the precision with which an estimate from a single sample approximates the population value.
The margin of error in social science research generally ranges from 3% to 7% and is closely related to sample size. A margin of error will get narrower as the sample size increases. The margin of error selected depends on the precision needed to make population estimates from a sample.

ii) **Confidence level**
It is the estimated probability that a population estimate lies within a given margin of error.
Confidence levels are also closely related to sample size. As the confidence level increases, so too does the sample size.
A researcher that chooses a confidence level of 90% will need a smaller sample than a researcher who is required to be 99% confident that the population estimate lies within the margin of error.

Looking at it another way, with a confidence level of 95%, there is a 5% chance that an estimate derived from a sample will fall outside the given confidence interval.

iii) Proportion (or percentage)

Proportion of a sample that will choose a given answer to a survey question is unknown, but it's necessary to estimate this number since it is required for calculating the sample size.

When determining the sample size needed for a given level of accuracy (i.e., given confidence level and margin of error), the most conservative estimate of 50% should be used because it is associated with the largest sample size.

10. It is intended to conduct a survey of disabled persons in a certain locality of Nepal. The prior known disability rate was 10%. What should be the sample size for the survey if the desired error of estimation is 5 %.

[TU 057]

Solution: Given

$$P = 10\% = \frac{10}{100} = 0.1$$

$$Q = 1 - P = 1 - 0.1 = 0.9$$

Desired error $(d) = 5\% = \frac{5}{100} = 0.05$

(When level of significance is not given, generally it assumed to be 5%)

Then, $\alpha = 5\%$

We have,

$$n_0 = \frac{t^2_{\alpha/2} pq}{d^2} = \frac{1.96^2 \times 0.1 \times 0.9}{(0.05)^2} = 144$$

Again we know that,

$$N = n = \frac{n_0}{1 + \frac{n_0}{N}}$$

For population size $N \to \infty, \frac{n_0}{N} \to 0$

Hence $n = n_0$

$\therefore N = 144$

11. Explain what you know about sampling. What are the steps to be followed in sampling? Also describe different types of sampling units used socio-economic survey. Also discuss how this population is defined. [TU 058]

See Q.No. 1

12. What is sampling? What are the steps to be followed in planning of a sample selection? Percentage of disabled persons in Nepalese populations is assumed to be not more than 5%. What should be sample size for national level survey for estimating disabled persons in Nepal with 5% errors in estimation of 5% level of signification? [TU 060]

For first part Q. No. 1

Numerical part

Solution:

Given,

$$P = 5\% = \frac{5}{100} = 0.05$$

$$Q = 1 - P = 1 - 0.5 = 0.95$$

Desired error $(d) = 5\% = \frac{5}{100} = 0.05$

Level of signification $(\alpha) = 5\%$

$t\alpha_{12} = 1.96$

Now we have,

$$= \frac{(t\alpha_{12})^2 \, pq}{d^2} = 52.35 \approx 53$$

Again, we know that

$$n = \frac{n_0}{1 + \frac{n_0}{N}}$$

Since $N \to \infty, \frac{n_0}{N} \to 0$

Here, $n = 53$

13. Discuss what you understand by probability sampling and non-probability sampling.

Discuss briefly different sampling scheme that come under these categories. From a population of size 300. 30 persons are selected by using simple random sampling. The mean height of the persons selected is found as 5 ft. Find the 95% confidence limits of the mean height of the population. (t – Value for 5% level of significance = 1.96)　　　　　　　[TU 063]

For theory part-see Q, No.2

Numerical Part

Solution:

Given, t-value of 5% level of significance = 1.96

size of population (N) = 300

size of sample (n) = 30

Mean height $\overline{X} = 5$

Standard deviation(σ) = 2

We know that,

Confidence limit for 95% = $\overline{X} \pm t\alpha_{12} \times$ S.E.

Where standard error (S.E.) is given by,

$$\text{S.E.} = \frac{\sigma}{\sqrt{n}} = \frac{2}{\sqrt{30}} = 0.365$$

$\therefore$　　C.I. $= 5 \pm 1.96 \times 0.365 = 5 \pm 0.72 = (5.72, 4.28)$

14. What is sampling? What are the steps to be followed on sampling? A researcher wants to conduct a survey of disables at Kathmandu valley, What should be the sample size if prior estimation of disables in the population is 10% and the desired error in estimation of proportion is 2% and the level of significance is 5%?　　　　　　[TU 064]

For first part, see Q. No. 1

Numerical

Here,　P $= 10\% = \dfrac{10}{100} = 0.1$

　　　　Q $= 1 - P = 1 - 0.1 = 0.9$

Desired error of estimation (d) = 2%

$$= \frac{2}{100} = 0.02$$

$$\alpha = 5\%$$

Then $t\,\alpha_{12} = 1.96$

Sample sixe (n) = ?

Now, we have,

$$n_0 = \frac{(t\alpha_{12})^2\, pq}{d^2}$$

$$= \frac{(1.96)^2 \times 0.1 \times 0.9}{(0.02)^2}$$

$$= 864.36\,[\text{Note: If sample size come in decimal value then}$$
$$\approx 865 \text{ the higher value next to it is taken}]$$

Again, we have

$$n = \frac{n_0}{1 + \frac{n_0}{N}}$$

But, for large population, $N \to \infty, \frac{n_0}{N} \to 0$

then, $n = n_0$

$$n = 865$$

Sample size (n) = 865

15. Discuss what you know about probability and non-probability samples. Discuss briefly different samples schemes that come under these categories. **[TU 064]**

[See Q. No. 2]

16. Discuss what you understand by probability sampling and non-probability sampling and their role in statistical inferences. A survey has to be conducted to estimate the prevalence role of a certain attribute in a population. Estimate the sample size required at 95% confidence level with desired error of 2% of estimation of 10% population? (t-value for 5% level of significance = 1.96)

[TU 066)]

[*For theory part, See Q. No. 2*
From Numerical part, See Q. No. 14]

17. **What is sampling frame? What are its requisites? Explain the essential characteristics of a good sample. Also discuss the advantage of sampling technique.**

Solution:

Sampling frame

Sampling frame refers to the list of population units from which the sampling units are selected. If this list is not available, it should be prepared before conducting the main survey.

Some requisites of the sampling frame are:

➢ It should be exhaustive i.e. all population units must be included in the list.

➢ In should be up to date i.e. it must include latest additions to the population.

➢ It should contain full information about the units so that an appropriate sample design may be planned.

➢ It should not contain the repeated unit.

➢ It should be suitable for the coverage of the study.

➢ It must be reliable.

Characteristics of good sample see Q.NO.1

Advantage of sampling technique, See Q.No. 2

18. **What is sampling? What are the steps o be employed in sampling method? Also discuss the process of selecting random samples.**

Solution:

Sampling steps to be employed, see Q.No. 1

Process of selecting sample, see Q.No. 2.

19. **What is sampling? What are the steps to be followed in sampling? It has been estimated by cable companies that 60% of all households of Kathmandu valley are wired to receive cable TV You would like to test the claim with 5% error and 95% level of confidence. How large a sample would you require?**

Soution:

[*For theory, See Q.No. 1*]

Numerical

Given, $P = 60\% = \dfrac{60}{100} = 0.6$

$q = 1 - P = 1 - 0.6 = 0.4$

Desired error $(d) = 5\% = \dfrac{5}{100} = 0.05$

Level of confidence $= 95\%$

i.e. Level of significance $= 5\%$

$t\,\alpha_{12} = 1.96$

Now, we have

$$n_0 = \frac{t\,\alpha_{12}^{2}\,PQ}{d^{2}}$$

$$= \frac{(1.96)^{2} \times 0.6 \times 0.4}{(0.05)^{2}}$$

$$= \frac{0.211}{25 \times 10^{-4}}$$

$$= 96$$

Again, we know that

$$n = \frac{n_0}{1 + \dfrac{n_0}{N}}$$

Since N is large, $N \to \infty$ then $\dfrac{n_0}{N} \to 0$

Then $n = n_0 = 96$

20. What are sampling and non-sampling errors?

Solution:

The errors involved in the collection of data are classified into sampling and non-sampling errors.

i. Sampling errors

Sampling errors are absent in census surveys. But it arises in sampling method due to the fact that only a part of the population has been used to estimate population parameters and to draw inferences about the population. Sampling errors can be measured for a given sample design and size.

The measurement of sampling error is usually called the 'precision of the sampling plan'. If we increase the sample size the precision can be improved. But a large sized sample increases the cost of collecting data and also enhances the systematic bias.

Thus the effective way to increase precision is usually to select a better sampling design which has a smaller sampling error for a given sample size at a given cost.

ii. Non- Sampling errors

Non- Sampling errors arises at the stage of collection and preparation of data and thus are present in both the sample survey as well as the census survey. Thus the data obtained in census survey is free from sampling errors, however subjected to non - sampling errors.

Non- sampling errors can be reduced by defining the sampling units, frame and the population correctly and by employing efficient people in the investigations.

21. A quality control engineer wants to estimate the fraction of defectives in a large lot of film cartridge from previous experience she feels that the actual fraction of defectives should be somewhere around 0.05. How large a sample she should take if she wants to estimate the true fraction within 0.01, using 95% Probability? [TU 070]

$P = 0.05$

$(d) = 0.01$

In case no sample is given.

Solution:

Given $P = 0.05$

$q = 1 - 0.05 = 0.95$

Desired error of estimation (d) = 0.01

For α 5 %, $t_{\alpha/2}$ = 1.96

Sample size (n) = ?

We have, $n_0 = \dfrac{t_{\alpha/2}^2 \, pq}{d^2}$

$= \dfrac{1.96^2 \times 0.05 \times 0.95}{(0.01)^2}$

$= \dfrac{3.8416 \times 0.0475}{1 \times 10^{-4}}$

$= 3.8416 \times 475$

$= 1824.76$

Again, We have

$$n = \frac{n_0}{1 + \frac{n_0}{N}}$$

For large population size, $N \to \infty$, $\frac{n_0}{N} \to 0$

Here, $n = n_0$

$$N = 1824.76 \approx 1825$$

22. Define and differentiate between simple random sampling and multistage sampling. If a simple random sample from a population of 5000 items is to be drawn to estimate the 10% defective within 4% of the true value with 95% confidence interval, what should be the size of sample? ✗ 5% [TU 2072]

Solution:

[For Theoretical Part See Q.No. 2]

Numerical

$$\frac{t_{\frac{\alpha}{2}} \times pq}{d^2}$$

N = 5000

P = 10% = 0.1

q = 1–P = 1–0.1 = 0.9

d = 4% = 0.04

for α = 5%, $t_{\alpha 12} = 1.96$

We have,

$$n_0 = \frac{t^2_{\alpha 12}\, pq}{d^2} = \frac{1.96^2 \times 0.1 \times 0.9}{(0.04)^2} = \frac{0.3457}{0.0016} = 216$$

Again we know that,

$$n = \frac{n_0}{1 + \frac{n_0}{N}} = \frac{216}{1 + \frac{216}{5000}} = \frac{216}{1 + 0.0432} = \frac{216}{1.0432} = 207$$

23. A population is estimated to have a standard deviation of 10. We want to estimate the population mean within 2, with a 95% level of confidence. How large a sample is required? ↓ [TU 076]

desired error

Solutions:

Standard deviation (α)= 5% = 0.05

Confidence level = 95%

$$\frac{t^2_{\frac{\alpha}{2}} \times \sigma^2}{d^2}$$

$t_{\alpha/2}$ at 95% level of confidence = 1.96

(i.e. 5% level of significance)

desired error of estimation (d) = 2

Sample size (n) = ?

We have

$$n = \frac{t_{\alpha/2}^2 \, \sigma^2}{d^2} = \frac{1.96^2 \times 10^2}{2^2} = \frac{3.8416 \times 100}{4} = 96.$$

Hence, the sample size of measurement to be taken is 96.

Some problems that may be asked

1. If the guess value of population mean is 50 and s.d. = 19 and the desired error in estimation of this value is 5% , then find out the sample size.

Solution:

Given, Desired error of estimation $(\lambda) = 5\%$ of 50

$$= \frac{5}{100} \times 50 = 2.5$$

for $\alpha = 5\%$

$t_{\alpha/2} = 1.96$

s.d. $(\sigma) = 19$

We have,

$$n_0 = \frac{t_{\alpha/2}^2 \sigma^2}{d^2} = \frac{1.96^2 \times 19^2}{2.5^2} = 221.8$$

$\therefore \quad n_0 = 221.8$

2. If the guess value of population mean is 19 and s.d. = 8, N = 433 and the desired error in estimation of this value is 10% . Then find n_0 and n.

Solution:

Given, d $= 10\%$ 0f $19 = \frac{10}{100} \times 19 = 1.9$

for $\alpha = 5\%$

$t_{\alpha/2} = 1.96$

s.d. $(\sigma) = 8$

N = 433

Now,

We have

$$n_0 = \frac{t_{\alpha/2}^2 \sigma^2}{d^2} = \frac{1.93^2 \times 8^2}{1.9^2} = 68.1$$

$\therefore \quad n_0 = 68.1$

Again,

We know that

$$n = \frac{n_0}{1 + \frac{n_0}{N}} = \frac{68.1}{1 + \frac{68.1}{433}} = 59$$

$\therefore \quad n = 59$

$$n = \frac{n_0}{1 + \frac{n_0}{N}}$$

3. If P = 0.5, α = 5%, d = 10% and N = 300 . Then find n_0 & n.

Solution: Given,

$$p = 0.5$$
$$q = 1 - p = 1 - 0.5 = 0.5$$
$$d = 10\% = \frac{10}{100} = 0.1$$

$P_t Q$

for α = 5%

$$t_{\alpha/2} = 1.96$$
$$N = 300$$

We have, $n_0 = \dfrac{t_{\alpha/2}^2 \, P\theta}{d^2} = \dfrac{1.96^2 \times 0.5^2}{0.1^2} = 96$

∴ $n_0 = 96$

Again, we know that

$$n = \frac{n_0}{1 + \dfrac{n_0}{N}} = \frac{96}{1 + \dfrac{96}{300}} = 73$$

∴ n = 73

4. A survey is to be conducted to investigate characteristics of a factor in a population of size 500, having the variance 85. Determine the sample required for error of 2 in estimation of population mean for 5% level of significance.

Solution: Given,

$$\sigma^2 = 85$$
$$N = 500$$
$$d = 2$$

for α = 5%

$$t_{\alpha/2} = 1.96$$

We have,

$$n_0 = \frac{t_{\alpha/2}^2 \, \sigma^2}{d^2} = \frac{1.93^2 \times 8^2}{2^2} = 82$$

∴ $n_0 = 82$

Again, we know that

$$n = \frac{n_0}{1 + \dfrac{n_0}{N}} = \frac{82}{1 + \dfrac{82}{500}} = 70$$

∴ n = 70

5. Suppose CV = 38% and p = 5% in estimation of μ by $\bar{X}$, then find out n_0.

Solution: Given,

$$CV = 38\% = 0.38$$
$$p = 5\% = 0.05$$
$$\text{for } \alpha = 5\%$$
$$t_{\alpha/2} = 1.96$$

We have,

$$n_0 = \frac{t_{\alpha/2}^2 (cv)^2}{p^2} = \frac{1.96^2 \times 0.38^2}{0.05^2} = 221.8$$

$$\therefore n_0 = 221.8$$

6. Suppose CV = 10% and p = 5% in estimation of μ by $\bar{X}$, then find out the n_0.

Solution:

Given, $CV = 10\% = 0.01$

$$p = 5\% = 0.05$$
$$\text{for } \alpha = 5\%$$
$$t_{\alpha/2} = 1.96$$

Then,

We have

$$n_0 = \frac{t_{\alpha/2}^2 (cv)^2}{p^2} = \frac{1.96^2 \times 0.01^2}{0.05^2} = 15.26$$

$$\therefore n_0 = 15.26$$

$$n_0 = \frac{t^2_{\frac{\alpha}{2}} (cv)^2}{p^2}$$

$$n_0 = 15 \cdot 26$$

Questions for Practice

1. Define sampling. Discuss the needs of sampling for a research work. Also, differentiate between sampling error and non-sapling error.

2. What are sources of sampling and non-sampling error? Disscuss. Also explain the steps to be adopted in sampling technique.

3. What is sampling? Describe different methods of random sampling.

4. What is sample-random sampling? Describe methods of selecting sample with replacement and without replacement in such sampling.

5. What is stratified sampling? Discuss the conditions under which stratified sampling is more suitable than sample random sampling.

6. Define and differentiate between stratified sampling and cluster sampling.

7. What is systematic sampling? Describe situations in which systematic sampling in useful.

8. What is cluster sampling?. When cluster sampling is more effective than other method of sampling.

9. What is multistage sampling? When multistage sampling is more effective than single stage sampling.

10. What is non probability sampling? Describe the conditions under which the non probability samplings are preferred?

11. Differentiate between i) convenience sampling and purposive sampling, ii) snowball sampling and quota sampling.

12. What is quota sampling? Discuss the area under which it is applicable.

13. What is snowball sampling? Discuss the area under which it is applicable.

14. What are the steps of sample survey? Describe.

15. What are factors affecting sample size?

16. How can you test the reliability of sample? Discuss.

17. Define the terms: i) sampling frame, ii) sampling error, iii) sample size, iv) population, v) sampling unit and vi) sample

18. Determine the minimum sample size required so that the sample estimate lies within 5% of the true value with 99% level of confident of variation is 40%.

19. What should be the size of sample if a simple random from a population of 4000 items is to be drawn to estimate the percent defective within 2% of the true value with 95% probability? Why would be the size of sample if the population is assumed to be infinite?

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