Frequently Asked Questions

1. Write a note on Optimum Allocation.

Answer:

*Optimum allocation (or Disproportionate allocatio*n) - Each stratum is proportionate to the standard deviation of the variable. Larger samples are taken in the strata with the greatest variability to generate the least possible sampling variance.

This allocation method is given by Neyman (1934). Here, the basic idea is that, for population with larger variability, sample sizes have to be large. That is, we should take larger allocation sample sizes for strata with higher variability.

If the sample size in the h^{th} stratum is directly proportional to the product of the population size in the h^{th} stratum and the population root mean square in the h^{th}

stratum i.e., $n_h \propto N_h S_h$ then the sample is said to have been selected under Optimum allocation or Neyman's allocation. Also, as we want that larger strata should have a higher allocation, so, to improve the precision of estimates (i.e., to reduce the variance), an important criterion of allocating the sample sizes should be to minimise the variance of stratified sample mean for a fixed total sample size, n and for a fixed cost C

2. What are primary reasons for using stratification?

Answer:

There are four primary reasons for using stratification

1) The subpopulations that form the strata are the domains of study or interest and thus we need to get separate estimates for each stratum. For eg: We may take separate samples for men and women because we are interested in making the separate inferences for subpopulations as well as comparing them.

2) The subpopulations or strata are such that different methods or sampling schemes may be suitable for different strata. For eg: If we are estimating the number of words in a text book we might take different samples from different sections; the front matter, the main text, the references, and the index

3) The population is geographically diverse and hence the stratification is more suitable and thus stratification is a convenient way of organizing sampling and data collection

4) By employing stratification in a careful fashion we can get improved precision for our estimates of population quantities

3. What are the points to be considered under Optimum (Neyman) Allocation?

Answer:

One has to consider the following points under Optimum (Neyman) Allocation

- Given a fixed budget, how should sample be allocated to get the most precision from a stratified sample?
- Given a fixed sample size, how should sample be allocated to get the most precision from a stratified sample?
- Given a fixed budget, what is the most precision that I can get from a stratified sample?
- Given a fixed sample size, what is the most precision that I can get from a stratified sample?
- What is the smallest sample size that will provide a given level of survey precision?
- What is the minimum cost to achieve a given level of survey precision?
- Given a particular sample allocation plan, what level of precision can I expect?

4. When do we have to take larger sample?

Answer:

In a given stratum take a larger sample if

1) The stratum is larger
2) The stratum is more variable internally
3) Sampling is cheaper in the stratum

5. Write a note on characteristics used for stratification.

Answer:

As a general rule, strata are created on the basis of a variable known to be correlated with the variable of interest and for which information on each universe element is known. Strata should be constructed in a way which will minimize the differences among sampling units within strata and maximize difference among strata

For example: If we are interested in studying the consumption pattern of the people of Delhi , the city of Delhi may be divided into various parts (such as zones or wards) and from each part a sample may be taken at random. Before deciding about stratification we must have knowledge of the traits of the population. Such knowledge may be based upon expert judgment, past data, preliminary observations from pilot studies etc.

The purpose of stratification is to increase the efficiency of sampling by dividing a heterogeneous universe in such a way that i) there is a great homogeneity as possible within each stratum and (ii) a marked difference is possible between the strata.

6. What are the merits and demerits of Optimal Allocation?

Answer:

Merits:

1. When larger variation is present in the subgroups optimal allocation is the suitable technique
2. Optimal allocation gives more précised estimates than other techniques of selection of samples.
3. Gives most precision for the least cost

Demerits:

1. Computation procedure is not easy as Proportional Allocation
2. Optimum Allocation requires the knowledge of S_h , the population root mean square deviation which is usually unknown

7. What all points to be considered to take advantage of Optimum stratification?

Answer:

More variable strata should be sampled more intensely. The number of sampling units drawn from each stratum is allocated according to analytical considerations e.g. as variability increases sample size of stratum should increase

Hence Optimum Allocation needs “weighted analysis”.

1. The number of sampling units drawn from each stratum is determined on the basis of both size and variation.
2. Calculated statistically

8. How do you decide about the number of observations that should be taken from each stratum?

Answer:

When deciding this question we can use either a proportional or a disproportional allocation. In proportional allocation one sample each stratum in proportion to its relative weight. In disproportional allocation this is not the case. With either approach, stratified sampling guarantees that every element in the population has a chance of being selected. It may be pointed out that proportional allocation approach is simple and if all one knows about each stratum is the number of items in that stratum; it is generally also the preferred procedure. In disproportional sampling the different strata are sampled at different rates. As a general rule when variability among observations within a stratum is high, one samples that stratum at a higher rate than for strata with less internal variation.

9. When does Optimum allocation give precise estimates?

Answer:

When there is high variation between strata we get high precision under Optimum Allocation than Proportional Allocation. But in practice the gain by switching from SRS to Proportional Allocation is much bigger than by switching from Proportional Allocation to Optimum Allocation. In Optimum Allocation we need to know the stratum variances in order to obtain the samples sizes for each stratum which could be more problematic. However in Proportional Allocation we only need to know the fraction of the units falling into each stratum. This information is much readily available or at least easier to approximate.

10. When population root mean square deviation is unknown, how do we go for Optimum Allocation?

Answer:

When S_h is unknown we go for estimation of S_h. Evans (1951) examined the effects of errors in the estimated S_h. and developed an approximate rule showing whether an estimated optimum is likely to be more precise than proportional allocation. He supposes that the coefficient of variations of the estimated S_h is the same in all the strata. This assumption is appropriate when the S_h have been estimated from preliminary samples of the same size in each stratum. He shows how to compute the size of the preliminary samples needed to make an optimum allocation better, on an average than proportional allocation. Previously Sukhatme (1953) showed that a small initial sample usually gives a high probability that optimum allocation will be superior to proportional allocation.

But it may be observed that the larger the difference in the values of S_h's smaller is the value of 'n'. Hence unless S_h's are homogeneous even moderately small values of n' will give on the average more precise estimates than proportional allocation.

11. What are the objectives of stratification?

Answer:

Reducing bias and underrepresentation is the aim of stratification, however unless the strata are carefully chosen the sampling error and bias can sometimes be increased via this method. Researchers must take precautions to choose the factors correctly and assign the strata properly. For example, researchers might set strata based on race for an election poll, not foreseeing that race would not have a major effect on voting. Optimum allocation is also particularly tricky as several calculations and estimations need to be made to choose the sample allocations.

12. How do we select the allocation techniques?

Answer:

Stratified Optimum sampling is used to eliminate possible errors that can occur with simple random or systematic sampling. However, as with any sampling method, the researchers' knowledge and experience play an important role in how accurate the final results may be.

Proportional allocation is advisable when all we know of the strata is their sizes. In situations where the standard deviations of the strata are known it may be advantageous to make an Optimum allocation.
Suppose that, once again, we had stratum A and stratum B, but we know that the individuals assigned to stratum A were more varied with respect to their opinions

than those assigned to stratum B. Optimum allocation minimizes the standard error of the estimated mean by ensuring that more respondents are assigned to the stratum within which there is greatest variation.

Optimum Allocation takes account of stratum sizes, different variances, and different costs of sampling in different strata. Optimal Allocation is not used as much as proportional allocation but it can result in a gain in precision if the costs and variances are known or well estimated from a prior study or a pilot survey.

13. What are the demerits of Stratified Random sampling?

Answer:

1) As already pointed out the success of the stratified sampling depends on
   i) Effective stratification of the universe into homogeneous strata
   ii) Appropriate size of the samples to be drawn from each stratum

   If Stratification if faulty the results will be biased. The error due to wrong stratification cannot be compensated even by taking large samples

   The allocation of the sample sizes to different strata requires an accurate knowledge of the population size in each stratum N_h , h = 1,2,..,k. Neyman's principle of Optimum allocation n_h proportional to N_hS_h requires addition knowledge of the variability or S.D of each strata . N_h and S_h are usually unknown and are the serious limitations of effective use of stratified random sampling

2) It is a very difficult task to divide the universe into homogeneous strata
3) If the strata are overlapping, unsuitable or disproportionate the selection of the samples may be biased. Such errors cannot be compensated even by taking large samples.
4) Disproportionate stratification requires weighting which again introduces selective factor in the sample and under weighing makes the sample unrepresentative

14. What are the practical limitations of Optimum Allocation?

Answer:

There are a number of practical limitations which restrict the use of Optimum

allocation in practice.

1) The most serious limitation of " Optimum Allocation" is the absence of the knowledge of $S^{h,}$s in advance. Inorder to overcome this difficulty a pilot survey of size n may first be carried out in order to provide the estimates of S^{h} (h = 1,2,….k). These estimated values of

$S^{h,}$s may be used in obtaining optimum values of n^{h} to be allocated in different strata .

However these extimates are subject to sampling errors and in case $S^{h,}$s are happen to be estimated with low precision then the advantage of optimum allocation may be lost and we might even be worse off as compared to proportional allocation.

Sukhatme(1935) obtained the expression n' (the size of the pilot survey) in order that y bar st under Neyman's Allocation based on the estimated $S^{h,}$s may not. On the average lead to loss of precision as compared to proportional allocation and is given by

$$n' = \frac{(\sum_{h=1}^{k} W_h S_h)^2 - \sum_{h=1}^{k} W_h S_h^2}{2\sum_{h=1}^{k} W_h (S_h - \bar{S})^2}$$

From the above it may be observed that the larger the difference in the values of $S^{h,}$s smaller is the value of 'n'. Hence unless $S^{h,}$s are homogeneous even moderately small values of n' will give on the average more precise estimates than proportional allocation

2)If our study relates to the estimation of more than one population characteristic from the sample survey, then the Neyman's allocation of the sample to different strata on the basis of one characteristic may result in loss of precision on other characters as compared to the method of Proportional allocation

3)Sometimes it may happen that the optimum values of nh in any stratum may be greater than N^h, the total number of units in that stratum. In such situation we take $n^h = N^h$ for the stratum requiring 100% sampling while for the other strata the optimum sample is recalculated

- High cost; low frequency of use
- Requires sampling frame
- Does not use researchers' expertise

15. What are the silent features of Optimum Allocation?

Answer:

Optimum allocation may be applied focusing on cost only, precision only, or both cost and precision jointly. Homogeneous strata with a smaller sample size can have the same level of precision as heterogeneous strata with a larger sample size. Applying this principle, it may be useful to make the number of elements selected from each stratum directly related to the standard deviation of the variable of interest in the stratum.

The greater the variability of the variable in a stratum, the higher the sample size of the stratum should be. Moreover, taking into account data collection costs, the higher the data collection costs of a stratum, the lower the Marketing Region Population . If data collection costs for the various districts are unavailable or essentially the same, one may yet optimize the sample sizes of the various strata by allocating the sample size of each stratum by taking into account the variability of the strata. This type of allocation was first proposed by Jerzy Neyman (1934), and is often referred to as the Neyman allocation.