Frequently Asked Questions

1. What do you mean by Systematic Sampling?

Answer:

Systematic sampling (or interval random sampling) is a probability sampling procedure in which a random selection is made of the first element for the sample, and then subsequent elements are selected using a fixed or systematic interval until the desired sample size is reached.

This is a technique, which has a nice feature of selecting a whole sample with just one random start. A sampling technique in which first unit is selected with a help of random numbers and the others get selected automatically according to some pre-designed pattern until the desired sample size is reached is known as systematic random sampling.

2. Write a note on random start.

Answer:
The researcher selects an integer that must be less than the total number of individuals in the population. This integer will correspond to the first subject. The number r is known as the random start. R can be any number from 1 to k where k = N/n. If r is a random start then a systematic sample of size n consists of the units r, r+k, r+2k, r+3k, …, r+(n-1)k.

3. Define sampling interval.

Answer:

Suppose N is the population size and n is the required sample size. Then a sampling interval is nothing but the integer value of the ratio of population size and a sample size. i.e., a sampling interval k = integer value of N/n.

Hence, sampling interval (k) is obtained by dividing the number of elements in the sampling frame (N) by the targeted sample size (n). One should ignore a remainder and round down or truncate to the nearest whole number. Rounding down and truncating may cause the sample size to be larger than desired. If so, one may randomly delete the extra selections.

4. When the systematic sampling is more useful?

Answer:

Systematic sampling is often used instead of random sampling. It is also called an n^{th} name selection technique. After the required sample size has been calculated, every n^{th} record is selected from a list of population members. As long as the list does not contain any hidden order, this sampling method is as good as the random sampling method. Its advantage over the random sampling technique is simplicity. Systematic sampling is frequently used to select a specified number of records from a computer file. Systematic sampling is a modification of random sampling.

Generally, systematic sampling is easier, simpler, less time-consuming, and more economical than simple random sampling. If the ordering is unrelated to the study variables, but randomized, systematic sampling will yield results similar to simple random sampling. On the other hand, periodicity in the sampling frame is a constant concern in systematic sampling

The random start distinguishes this sampling procedure from its non-probability counterpart, non-probability systematic sampling. In some instances, a sampling frame is not used. The target population need not be numbered and a sampling frame compiled if there is physical presentation such as a continuous flow of population elements at specific locations. For example, after a random start, one may systematically select every ith patient visiting an emergency room in a hospital, store customers standing in line, or records in file drawers.

Hence, when the population is of homogeneous character if we know the starting sample observations required sample can be obtained automatically without the knowledge of the frame.

5. Explain the principal steps involved in selecting a systematic sample.

Answer:

Generally, there are eight major steps in selecting a systematic sample:

1. Define the target population.

2. Determine the desired sample size (n).

3. Identify an existing sampling frame or develop a sampling frame of the target population.

4. Evaluate the sampling frame for under coverage, over coverage, multiple coverage, clustering, and periodicity, and make adjustments where necessary. Ideally, the list will be in a random order with respect to the study variable or, better yet, ordered in terms of the variable of interest or its correlate, thereby creating implicit stratification. If the sampling frame is randomized, systematic sampling is considered to be a good approximation of simple random sampling.

5. Determine the number of elements in the sampling frame (N).

6. Calculate the sampling interval (i) by dividing the number of elements in the sampling frame (N) by the targeted sample size (n). One should ignore a remainder and round down or truncate to the nearest whole number. Rounding down and truncating may cause the sample size to be larger than desired. If so, one may randomly delete the extra selections.

If the exact size of the population is not known and impractical to determine, one may fix the sampling fraction.

7. Randomly select a number, r, from “1” through i.

8. Select for the sample, r, r + i, r +2i, r +3i, and so forth, until the frame is exhausted.

6. Write a note on distribution of sample observations in systematic sampling.

Answer:
We suppose that the population is of size N and the required sample size is n. Suppose k= N/n. Then, **N=nk** and let the selected random number be **r (<k), k** being called as a sampling interval. In this procedure a sample comprise of the unit **r, r+k, r+2k… r+(n-1)k .** the technique will generate **k** systematic samples with equal probability which may be shown as follows: Under systematic sampling let y_{ri} be the ith unit corresponding to the r^{th} sample r=1,2, ,k ; i=1,..,n.

Sample no					
1	2	**…**	i	**…**	k
y_1	y_2		y_i		y_k
y_{1+k}	y_{2+k}		y_{i+k}		y_{2k}
. . .	. . .		. . .	. . .	. . .
$y_{1+(n-1)k}$	$y_{2+(n-1)k}$				y_{nk}

7. What do you mean by linear systematic sampling?

Answer:

Linear systematic sampling is the most frequently used form of systematic sampling. The steps in selecting a linear systematic sample are the same as listed above.

We suppose that the population is linear in order in some way such that number can refer to units. Further let N be expressible in the form of **N=nk** and let the selected random number be **r (<k), k** being called as a sampling interval. In this procedure a sample comprise of the unit **r, r+k, r+2k… r+(n-1)k . T**he technique will generate **k** systematic samples with equal probability.

8. Explain circular systematic sampling.

Answer:

This is a scheme, which is modified slightly by which a sample of constant size is always obtained. The procedure consists in selecting a unit, by random start, from 1…N and thereafter selecting every k^{th} unit, k being an integer nearest to N/n, in a circular manner till a sample of size n units is obtained. This technique is generally known as circular systematic sampling. It can be easily verified that every unit has got equal probability of selection 1/N in this method. As an illustration N=11, n=4 &k=3. The possible samples are therefore (1, 4, 7, 10), (2, 5, 8, 11), (3, 6, 9, 1), (4, 7, 10, 2), (5, 8, 11, 3), (6, 9, 4), (7, 10, 2, 5), (8, 11, 3, 6), (9, 1 4, 7), (10, 2, 5, 8), (11, 3, 6, 9).

9. What do you mean by repeated systematic sampling?

Answer:

Repeated systematic sampling involves the selection of multiple samples from the target population and then combining them into a single sample. Instead of only one random start, several smaller systematic samples are selected using multiple random starts.

This makes the process more time-consuming than linear systematic sampling. However, repeated sampling minimizes the effect of bias due to periodicity, a regularly occurring pattern in the sampling frame (see below). Moreover, because linear systematic sampling generates only one "cluster" of elements (although the cluster may contain multiple elements), technically, an unbiased estimate of sampling error cannot be obtained without making certain assumptions.

At least two independently chosen clusters must be made. Repeated sampling provides more than one cluster of elements and facilitates the calculation of variances and standard error of estimates from the sample.

10. What are the advantages of systematic sampling?

Answer:

Systematic sampling is often used when it is impractical or impossible to use simple random sampling. When compared to simple random sampling, in some instances it is a stronger sampling procedure, and in other instances it is a weaker sampling procedure. Compared to simple random sampling, the strengths of systematic sampling include the following

- If the selection process is manual, systematic sampling is easier, simpler, less time-consuming, and more economical than simple random sampling. One needs to use a random process to select only the first element. On the other hand, if the selection process is computerized, the ease in the selection process of systematic sampling and simple random sampling may be comparable to each other.
- If the sampling frame has a monotonic ordering that is related to a study variable (e.g. ordering of stores by dollar value, listing of employees by number of years employed, and listings of schools by graduation rates), implicit stratification may result in the statistical efficiency. This is equivalent to that of proportionate stratified sampling and is thereby more efficient than simple random sampling. If the ordering is randomized, systematic sampling may yield results similar to simple random sampling.

- Systematic sampling ensures that the sample is more spread across the population.
- An advantage of systematic random sampling over simple random sampling is the assurance that the population will be evenly sampled. There exists a chance in simple random sampling that allows a clustered selection of subjects. This is systematically eliminated in systematic sampling.

The target population need not be numbered and a sampling frame compiled if there is physical representation. Combinations of elements have different probabilities of being selected. If the ordering of the elements in the sampling frame is randomized, systematic sampling may yield results similar to simple random sampling.

Technically, only the selection of the first element is a probability selection since for subsequent selections, there will be elements of the target population that will have a zero chance of being selected. If the ordering of the elements in the sampling frame is related to a study variable creating implicit stratification, systematic sampling is more efficient than simple random sampling. Principle of independence is violated, for the selection of the first element determines the selection of all others. Systematic sampling eliminates the possibility of autocorrelation.

11. How the precision of the systematic sample is affected by autocorrelation?

Answer:

Systematic sampling ensures that the sample is spread across the population. Similarity of adjacent elements in a list makes for autocorrelation, the correlation among elements in the population. Although rare, this may occur in simple random sampling. Spatial autocorrelation is likely to exist in a listing of addresses. Persons, who live at addresses that are close to each other are likely to be more similar to each other, say in terms of socioeconomic status, than they are to persons living at addresses that are not as close.

A positive autocorrelation creates lower precision, and a negative autocorrelation creates higher precision when compared to simple random sampling. However, systematic sampling eliminates the possibility of autocorrelation.

For example, in using a voter's list for the selection of a sample for a study of voter preferences, it is possible that members of the same family are selected using simple random sampling, but this is not possible using systematic sampling.

12. What are the limitations of systematic sampling?

Answer:

Systematic sampling has a number of weaknesses. Some of them include:

- Although its occurrence is relatively rare, periodicity in the sampling frame is a constant concern in systematic sampling. A biased sample could result if a periodic or cyclical pattern in the sampling frame corresponds to the sampling fraction.

This problem will exist if the sampling fraction is equal to or a multiple of a periodic interval in the list. For example, a systematic sample of students would be biased if students are listed by class and within each class ranked by performance on an achievement test. If the classes have approximately the same number of students, periodic bias will result.

- Moreover, whereas in simple random sampling every combination of n elements has an equal chance of selection, this is not the case for systematic sampling.

- Technically, only the selection of the first element is a probability selection since for subsequent selections there will be members of the target population that will have a zero chance of being selected.
- Principle of independence is violated, for the selection of the first element determines the selection of all the others.
- Estimating variances is more complex than that for simple random sampling.
- Systematic sampling may not represent the whole population.
- There is a chance of personal bias of the investigators.
- The process of selection can interact with a hidden periodic trait within the population. If the sampling technique coincides with the periodicity of the trait, the sampling technique will no longer be random and representativeness of the sample is compromised.

13. How do you select systematic samples from a population?

Answer:

Systematic sampling is a method of selecting sample members from a larger population according to a random starting point and a fixed periodic interval.

Typically, every "nth" member is selected from the total population for inclusion in the sample population. Systematic sampling is still considered as being random, as long as the periodic interval is determined beforehand and the starting point is random.

A common way of selecting members for a sample population using systematic sampling is simply to divide the total number of units in the general population by the desired number of units for the sample population. The result of the division serves as the marker for selecting sample units from within the general population. For example, if you wanted to select a random group of 1,000 people from a population of 50,000 using systematic sampling, you would simply select every 50th person, since 50,000/1,000 = 50

14. The process of obtaining the systematic sample is much like an arithmetic progression. Justify

Answer:

The process of obtaining the systematic sample is much like an arithmetic progression.

i. Starting number: The researcher selects an integer that must be less than the total number of individuals in the population. This integer will correspond to the first subject.
   The number r is known as the random start. If r is a random start then a systematic sample of size n consists of the units r, r+k, r+2k, r+3k, …,r+(n-1)k.

ii. Interval:
   The researcher picks another integer which will serve as the constant difference between any two consecutive numbers in the progression.

The integer is typically selected so that the researcher obtains the correct sample size.

For example, the researcher has a population total of 100 individuals and need 12 subjects. He first picks his starting number 5.Then the researcher picks his interval, 8. The members of his sample will be individuals 5, 13, 21, 29, 37, 45, 53, 61, 69, 77, 85, 97.

15. From a population of 100 food stores, select all possible systematic samples of size 20 food stores.

Answer:

Systematic sampling as applied to a survey of food stores

Population size N = 100 Food Stores

Sample desired n = 20 Food Stores

Hence k = N/n = 5

Hence, r can be any number from 1 to 5. We get 5 systematic samples

Which are listed below

Sample	Numbered Stores					
1	1,	6,	11,	16,	21...	96
2	2	7,	12	17,	22...	97
3	3,	8,	13	18,	23...	98
4	4,	9,	14	19,	24...	99
5	5,	10,	15,	20,	25...	100