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The Importance of Using Samples in Scientific Research

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Abstract:

The importance of conducting scientific research—either theoretical or applied—is the necessity to apply known scientific rules, methods, and principles. They are necessary not only to achieve the desired outcomes of the research but also for the sake of contributing to scientific knowledge through the results accumulated. The process involves the collection, analysis, and interpretation of data and information using various research tools and techniques. Of these, sampling has been selected because of its tremendous importance as a methodological and technical instrument in scientific research. The aim of this paper is to examine the importance of using sample in research, explore the ways of selecting the sample, and expound its implications on scientific research.

Keywords: Research Population; Sampling; Sample; Scientific Research.

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I. INTRODUCTION

Scientific research is beyond any doubt a requirement for all academic research because it assists the researcher or student to design and carry out research and understand social reality. One of the most important stages of the research process is understanding the research problematic and its assumptions or questions. This stage precedes the establishment of data collection instruments and facts regarding the subject of study. The research sample is a key feature in the carrying out of the various stages of scientific research. Its importance relies on the method of choosing it and determining an appropriate size for purposes of good representation of the initial population. Thus, the nature of the studied subject determines the sample size as well as its type. This study addresses this subject in the following main themes:

- Firstly: Definition of Concepts
- Secondly: The Importance of Using a Sample and Its Requirements
- Thirdly: Steps in the Selection of Sample
- Fourthly: Types of Samples
- Fifthly: Determinants of Sample Size in Scientific Research
- Sixthly: Mistakes in Sample Selection

With the theoretical part of a study for a given subject completed, the researcher takes a structured methodology in gearing up the fieldwork aspect. Prior to all else, the researcher needs to identify the research's population. Oftentimes, the population size is huge, and hence studying it as a whole would demand much more effort, time, and resources than are ever available. In such cases, it is essential to use sampling and choose an apt type that suits the nature and characteristics of the study subject. This also alludes to the key methodological problems that researchers face in carrying out the academic research. In relation to this, the central research question can be posed as follows: What are sampling applications in scientific research, and is sampling one of the key driving factors in ensuring that the study succeeds? Branches of this central question are the following sub-questions :

- What is a sample ?
- What are the principal types of samples ?
- How is a sample to be selected, and what are the essential conditions for calculating its size? What are the most common mistakes in the selection of a sample?

1. Definition of Concepts

1.1 Research Population

A research population is a set of elements that share one or more characteristics which distinguish them from other elements, and which form the focus of research or investigation (Angers, 2004, p. 298). In practical terms, it refers to all units or components of the phenomenon under study. For example, if the research topic examines Algerian youth perceptions of immigrants in European countries, the research population would be Algerian youth. Accurately defining this population ensures the feasibility and focus of the study.

1.2 Sampling

The term “sampling” is conceptually and methodologically linked to the term “sample,” as the latter results from the process of sampling—comparable to how digging produces a hole. This is to clarify that the two terms have also been confused. According to Angers, "sampling is a set of procedures that enable the selection of a subset of the research population with the aim of forming a sample..." It can also be defined as "a set of statistical processes used to choose a partial group from the population targeted by the study." (Jakhdel, 2019, p. 13).

1.3 Sample

In many cases, it is impractical for a researcher to study all the units of the entire population—what is known as a comprehensive survey—because of the population's size. Therefore, a selection of representative units is made, called a sample. A sample is defined as "a subset of the study population, chosen in such a way that it reflects the characteristics of that population and serves the purposes of the research." (Diab, 2013, p. 89). For instance, in medical testing, a doctor takes only a small blood sample from a patient to detect a disease, rather than using the patient's entire blood amount.

1.4 Scientific Research

"Scientific research refers to survey marked by an accurate organization aimed at acquiring new information, knowledge, or relationships, verifying and developing existing knowledge, and doing so through credible methods. It is an organized effort involving observation and experimentation that holds scientific value, and it can only be considered genuine research when conducted to address a specific academic or applied problem using the scientific method as its foundation" (Mohamed D. , 2017, p. 310). In essence, scientific research is the investigation of facts through the collection, analysis, and interpretation of information, in order to uncover the reality of phenomena and remove ambiguity or misunderstanding.

2. The Importance of Using a Sample and Its Requirements

In sociological research, data collection is often based on small groups of individuals who serve as representatives of the broader population. These participants are interviewed to obtain information that, on one hand, advances the aims of scientific research, and on the other, aids in interpreting social phenomena and identifying solutions to the issues under study.

For this reason, researchers in this field must ensure the use of a sample that accurately reflects the characteristics of the entire population. The importance of sampling in scientific research, as explicated by (Mohamed B. , 2014, p. 180), can be enumerated as follows:

- Efficiency of time and effort, with reduced costs, as research is conducted on a subset of the population possessing the same characteristics as the whole.
- Improved data quality from complete census, since it is not possible to cover all units of a population, and some of the units provide false data, so complete census may not be so useful.
- Faster data processing, from collection through summarization, tabulation, analysis, and interpretation.
- Better research outcomes when statistical methods such as means, standard deviations, and correlation coefficients are employed...
- Minimized participant fatigue, which can occur when members of a population are repeatedly surveyed by different researchers.
- More effective use of a small, trained data collection team, capable of delivering accurate and objective evidence on the topic.
- Thus, selecting an appropriate sample is vital for researchers, as it allows them to save time, effort, and costs while producing valid findings that can be generalized to the entire population.

Requirements for a Research Sample: When selecting a sample, researchers should adhere to the following requirements:

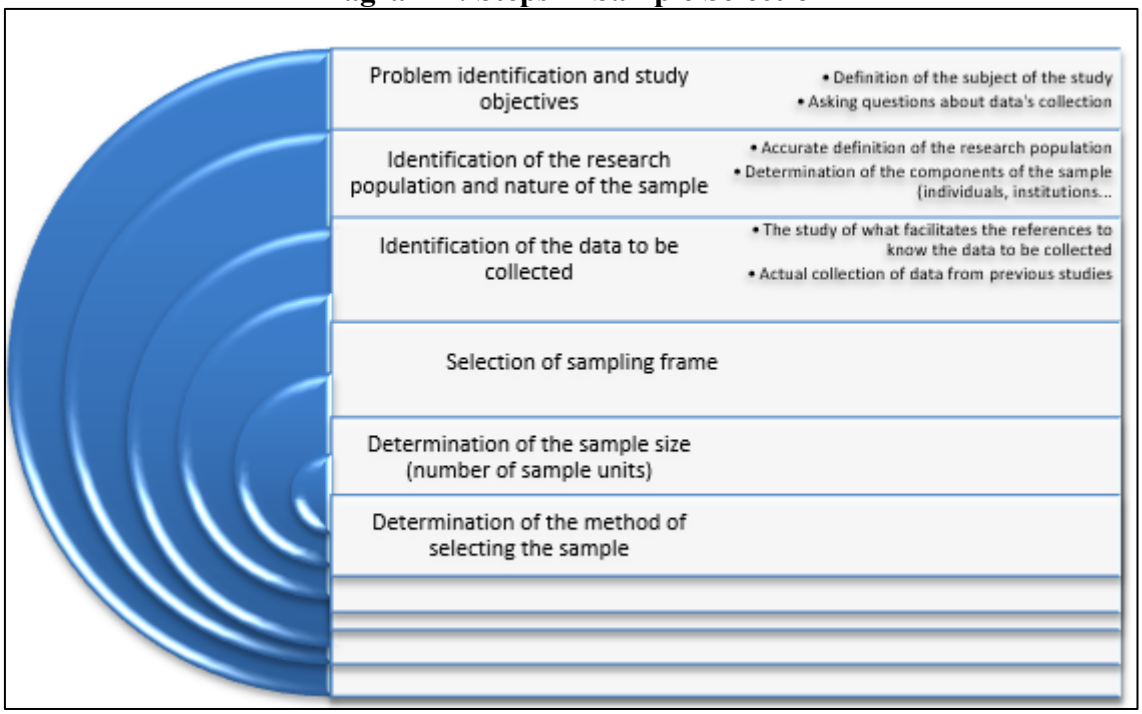
- Representativeness of the population, the sample must accurately mirror the population's key characteristics.
- Equal selection chances, every individual in the population should have the same likelihood of being chosen, free from researcher bias, favoritism or intervention (Al-Samarrai, 2014, p. 117).

- Sufficient sample size, the number of units in the sample must be adequate to ensure the precision and reliability of the results. S. Sudman observed that data obtained from a sample of 20,000 households in a social survey conducted by the U.S. Census Bureau were more accurate than those collected through the decennial complete census of the U.S. population (Talaat, 1955, p. 85).
- The nature of the research topic, as well as time and budget constraints, should be considered when determining the sample.
- Researchers may employ statistical calculations to determine a sample size suited to their available resources and timeframe.

3. Steps in the Selection of Sample

The researcher should begin by clearly defining the topic to be studied and verifying that it is appropriate for sampling. The next step is to determine the type of sample that will allow for accurate results with minimal cost, following the procedures illustrated in the following diagram:

Diagram 1: Steps in Sample Selection



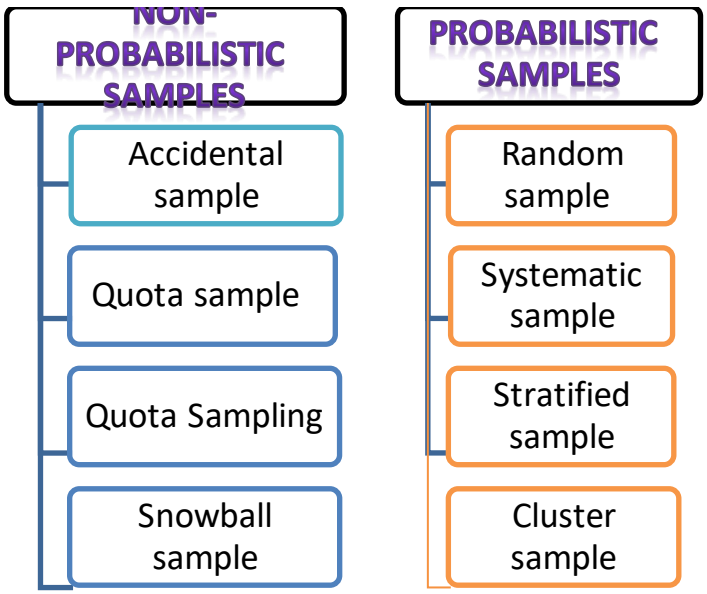
Source: (Aichour, 2017, pp. 233-253).

In brief, the selection of an appropriate sample depends on a thorough understanding of the subject under study, a clear articulation of the research objective(s), and precise identification of the research population and the nature of the sampling units—whether individuals, institutions, or content elements for analysis. The next step is to determine a sample size that is compatible with the researcher's available resources and time frame, followed by the selection of a sampling method, whether probabilistic or non-probabilistic.

4. Types of Samples

Most specialists agree that samples are generally classified into two main categories, as illustrated in the following diagram:

Diagram No. (2): shows the types of samples in scientific research



Source: Prepared by the researcher.

4.1 Probabilistic Samples

These are so called because each unit in the population has an equal probability of being included in the sample, with selection carried out at random. They can be divided into four principal types:

4.1.1 Simple Random Sampling –

A method in which units are selected from the sampling frame so that every unit of the population has an equal opportunity of being selected (Badawi, 1977, p. 364). This is the simplest and one of the most widely used methods, applicable when the entire population is known. Selection can be done by drawing slips of paper from a box without replacement until the required sample size is reached; or using random number tables, assigning each unit a number and selecting numbers by tracing lines until the needed count is achieved.

4.1.2 Systematic Sampling

"This type of sampling is characterized by systematic intervals or counts between the selected units, such that the distance between one selected unit and the next is the same in all cases" (Bouhouche & Al-Dhunaibat, 2016, pp. 65-66). It should be noted that the selection of the first unit is done randomly.

The sampling interval can be calculated using the following formula:

Sampling Interval = Population Size ÷ Sample Size

Steps for selecting a systematic sample:

- Define the research population.
- Determine the desired sample size according to the researcher's resources and the available time for completing the study.
- Prepare a list of all units in the population.
- Calculate the sampling interval using the formula above.
- Select a random starting number from 1–9; for example, if 5 is selected, it becomes the first unit. Then, add the calculated sampling interval to obtain the next unit, and continue this process until the required sample size is reached.

Example: Suppose a researcher wants to conduct a field study in an institution with 250 units and intends to select a sample of 25 units.

Sampling interval = 250 ÷ 25 = 10.

Assign each unit in the institution a number.

Randomly choose a starting number, e.g., (3). The selected units will be:

3 ,193 ,183 ,173 ,163 ,153 ,143 ,133 ,123 ,113 ,103 ,93 ,83 ,73 ,63 ,53 ,43 ,33 ,23 ,13 , — 243 ,233 ,223 ,213 ,203totaling 25 units.

4.1.3 Stratified Sampling

This sampling method is applied when the population is, or can be, divided into strata, each distinguished by a particular characteristic. The proportion of each stratum in the sample corresponds to its proportion in the overall population, with units within each stratum selected randomly. Compared with simple random or systematic sampling, stratified sampling yields a more precise representation of the population (Badawi, 1977, p. 364).

For a population of secondary school students, stratification might be based on gender, academic year, or major. The sample size for each stratum is calculated as:

Sample size for stratum= Total population size ÷ Population size of stratum ×Total sample size

Illustrative case: A pilot study reveals that the research setting consists of 80 literature students, 110 science students, and 60 technical-mathematics students. The researcher wishes to select a sample of 50 students:

Literature: 50×80÷250=16 students

Science: 50×110÷250=22 students

Technical-Mathematics: 50×60÷250=12 students

4.1.4 Cluster Sampling

This method is adopted when the population is large, and the aim is to reduce the expenses associated with sample selection. "It is akin to clusters in which natural units are geographically or temporally close to one another. A specified number of individuals is then chosen from each standard unit or cluster, either through simple random selection or using the cluster method itself". (Aleayan & Ghanim, 2010, p. 147).

Example: To investigate youth aspirations for their future in a particular city, one might apply cluster sampling by first identifying neighbourhoods on a city map. Both low-income and high-income areas are considered clusters. From these, the researcher selects specific districts, then specific buildings, and finally specific families whose members participate in the study.

4.2 Non-Probability Sampling

Non-probability sampling does not involve probabilistic selection. Instead, the researcher ppurposively selects the sampling. This category includes four main types:

4.2.1 Accidental Sampling –

The researcher selects individuals encountered by aaccident, ensuring reasonable representation of the research population. Advantages include easy access to participants, low cost, minimal effort, and time efficiency.

Example: Studying women's attitudes toward childbearing in a certain city by interviewing, on a accident aspect, women aged 18–49 who regularly visit the city's maternal and child health center for medical examinations. Their views on reproductive health may vary according to their socio-cultural and economic backgrounds.

4.2.2 Purposive Sampling –

Individuals are purposively selected to meet specific study objectives.

Example: Selecting a particular school to study the relationship between students and teachers.

4.2.3 Quota Sampling –

The researchers apply this method when they wish to gather the views of a group of individuals on a certain topic.

Example: To determine public opinion in a given population regarding women's participation in the workforce—where attitudes range from supportive to opposed—the sample is proportionally distributed based on demographic variables such as age, gender, or place of residence. For example, the sample may be set at 70% men and 30% women.

4.2.4 Snowball Sampling –

Unlike other sampling techniques, snowball sampling begins without a pre-established list of participants. The process starts with a single respondent who becomes the initial source of data and refers the researcher to other potential participants. Each subsequent participant provides further referrals, creating a chain of contacts that expands progressively—akin to a snowball increasing in size as it rolls.

5. Determinants of Sample Size in Scientific Research

Several determinants guide the researcher in selecting the appropriate sample size:

- Nature and objectives of the research .
- Financial capacity, available personnel, and the time allotted for research field data collection.
- Instruments' type of data collection.
- "When the population is highly diverse, a larger sample is necessary to reduce the likelihood of random sampling error stemming from differences between the sample units and the overall population. In such cases, increasing the sample size narrows the margin of error; in contrast, when the population is largely homogeneous, smaller samples may still yield reliable results.
- The characteristics of the population: Specifically, whether all elements of the population are known to the researcher in advance or not..." (Talaat, 1955, pp. 60-62). In cases where a list of all population elements or a mapping of the research field is available, the researcher is advised to employ probability sampling methods. If such information is unavailable, non-probability sampling methods are typically used .

6. Errors in Sample Selection

Researchers may encounter errors when selecting sampling methods or when failing to apply statistical selection techniques correctly. These errors typically take the form of bias or random error.

6.1 Random Error

"This error occurs because of the nature of random selection, where sample results may differ from the true population values. Its level depends on population variability, the selection procedure, and sample size: the larger the sample, the smaller the error and the higher the confidence in the results. While it cannot be entirely eliminated, it can be statistically estimated and controlled. Random error affects only sample estimates and does not occur in complete censuses". (Mahdi, 2007, p. 96).

Example: If we have 10 students in a class and their results in the methodology module are as follows- :

6,8,14,9,13,12,10,7,15,11 thus, the arithmetic mean of these results is:

$$\bar{X} = \frac{6,8,14,9,13,12,10,7,15,11}{10} = 85,6$$

While if we take a random sample of 6 students and their results are as follows: 13,12,10,7,15,11, thus, the arithmetic mean of the sample results is: -

$$\bar{X} = \frac{13,12,10,7,15,11}{6} = 57,1$$

It is noted that there is a clear difference between the arithmetic mean of the sample and the arithmetic mean of the original population.

6.2 Bias Error

This error arises from the researcher's bias for special points of view, as this error occurs not only in probabilistic samples, but even when using the complete census method. The factors for the occurrence of this type of error are:

- Lack of clarity of questionnaires questions for data collection.
- Incompetence of researchers in applying the steps of accomplishing scientific

research.

- Providing wrong answers by the respondents.
- "Replacing the sample participants with other units because the researcher was unable to reach some of the basic units in the sample.
- Miscalculation and lack of accuracy on the part of the researcher when conducting census and calculating the variables specific to the nature of the phenomenon or does not succeed in distinguishing between what is the cause or result or its failure to succeed in formulating the correct assumptions...

Bias errors are ones caused by the researcher's intervention in the method of selecting the sample. For example, it is known that the random sample largely represents the characteristics of the population from which it was drawn. If the sample is selected in a personal way (i.e. not random), this leads to an increase in expected errors." (Mahdi, 2007, p. 101).

II. Conclusion

The selection of the research sample is one of the most important steps in scientific research, and selecting it accurately and correctly is necessary to ensure the representation of the research population. This requires the researcher to wait and select the most appropriate sampling method, as each type of sample has its field of application according to the nature of the subject on the one hand, and its suitability with the researcher's capabilities and the time specified for conducting the study so that he can generalize the results on the phenomenon.

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