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SAMPLE SIZE DETERMINATION FOR SURVEY RESEARCH AND NON-PROBABILITY SAMPLING TECHNIQUES: A REVIEW AND SET OF RECOMMENDATIONS

Md. Mizanur Rahman

BRAC Business School, BRAC University, Bangladesh
E-mail: mizanmgt@gmail.com

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Abstract
If the researchers cannot collect data from a sufficient number of respondents using an appropriate sampling technique, it will be challenging for them to meet the study's primary objective. So, it is crucial for researchers to collect data from a large enough sample size and choose a suitable sampling method. Because there are so many different sampling strategies, and they come in such a wide range of forms, researchers need to have a solid understanding of how these techniques differ to select the method that will work best for their particular study. In this paper, the researcher addresses those crucial issues by setting two essential questions: a. what are the various non-probability sampling techniques? b. what the minimum possible number of participants required for survey research is? Non-probability sampling techniques have been discussed with the necessary example so that the readers can easily understand which method will be more appropriate for their study. In addition, some guidelines concerning the determination of appropriate sample size (sample size calculation using G* power, the sample size for categorical and continuous variables, sample to items, sample to variables, the sample size of CB-SEM, PLS-SEM) for survey research have been discussed in this study. This study will help researchers choose the non-probability sampling method(s) and minimum sample size to conduct their studies efficiently and fruitfully.

Research paper

Keywords: Sampling, non-probability sampling, sample size, survey research

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Introduction

In survey research, choosing the suitable sampling method and sample size are crucial steps (Rahman et al., 2022). Sampling is the process of selecting participants for a research study from a larger population using the research study's criteria (Turner, 2020; Ginty, 2013). Thus, it is a must to have a good knowledge of sampling techniques to conduct quality research (Berndt, 2020; Guest et al., 2020; Tripathi et al., 2020; Gill, 2020; Ratan et al., 2019). The fundamental goal of sampling is to obtain a representative sample, which consists of a limited number of examples or units selected from a much larger group or population. A representative sample is known as a "sample of representative units." As a result, the researcher can study the more limited group and draw legitimate conclusions about the more extensive group. The researchers usually focus their efforts on methods that would suggest them with samples that are pretty comparable to one another.

The researcher encounters a challenge when attempting to gather data using the appropriate sample technique. The research questions for the study cannot currently be answered because the researchers will not be able to collect data from every situation. The researcher must be familiar with the differences between the numerous and diverse sampling procedures and methodologies that are accessible to choose the most suitable one for the particular study under consideration (Rahman et al., 2022). In addition, to derive credible inferences from the outcomes of a study, one needs to determine the correct size of the study's sample population (Memon et al., 2020). Despite this, many individuals consider it one of the more challenging aspects of developing empirical research (Dattalo, 2008). Even though there are several Tables and general rules of thumb that can be employed, many researchers are still

unsure which one they should use to find out the appropriate sample size for social science study. This is especially true when they conduct surveys to collect information for their studies. The previous research has indicated that using a small sample size in empirical studies published in respected journals is one of the most significant issues arising with these types of investigations (Memon et al., 2020, Green et al., 2016; Uttley, 2019). In light of the challenges that have been outlined above, the purpose of this research is to investigate some of these problems regarding the questions that have been outlined below:

- What stages does a researcher need to follow to select a suitable sampling technique?
- What are the various non-probability sampling techniques?
- What are the minimum sample size for survey research?

In the first part of the introduction, the researcher highlighted the basic concepts of sampling techniques with their importance. In the second part, the challenges relating to selecting a sampling technique and determining the sample size usually a researcher faces while conducting research have been covered. Finally, based on the challenges, the researcher set objectives. The following steps include the research methods, discussions on non-probability sampling techniques and sample size determination.

Methods/Design

The information used in this article came from a wide range of sources, such as books, websites, books, and previously published research articles and papers. The flowchart (figure 1) explains how these were chosen

from various potential options. Figure 1 illustrates the types of publications that were considered for and rejected from further consideration at each level. Most of the material was looked through using Google Scholar as the databases of choice. It was determined that the following search phrases would be helpful: "non-probability sampling techniques", "types of sampling techniques", "sample size", and "sample size for survey research".

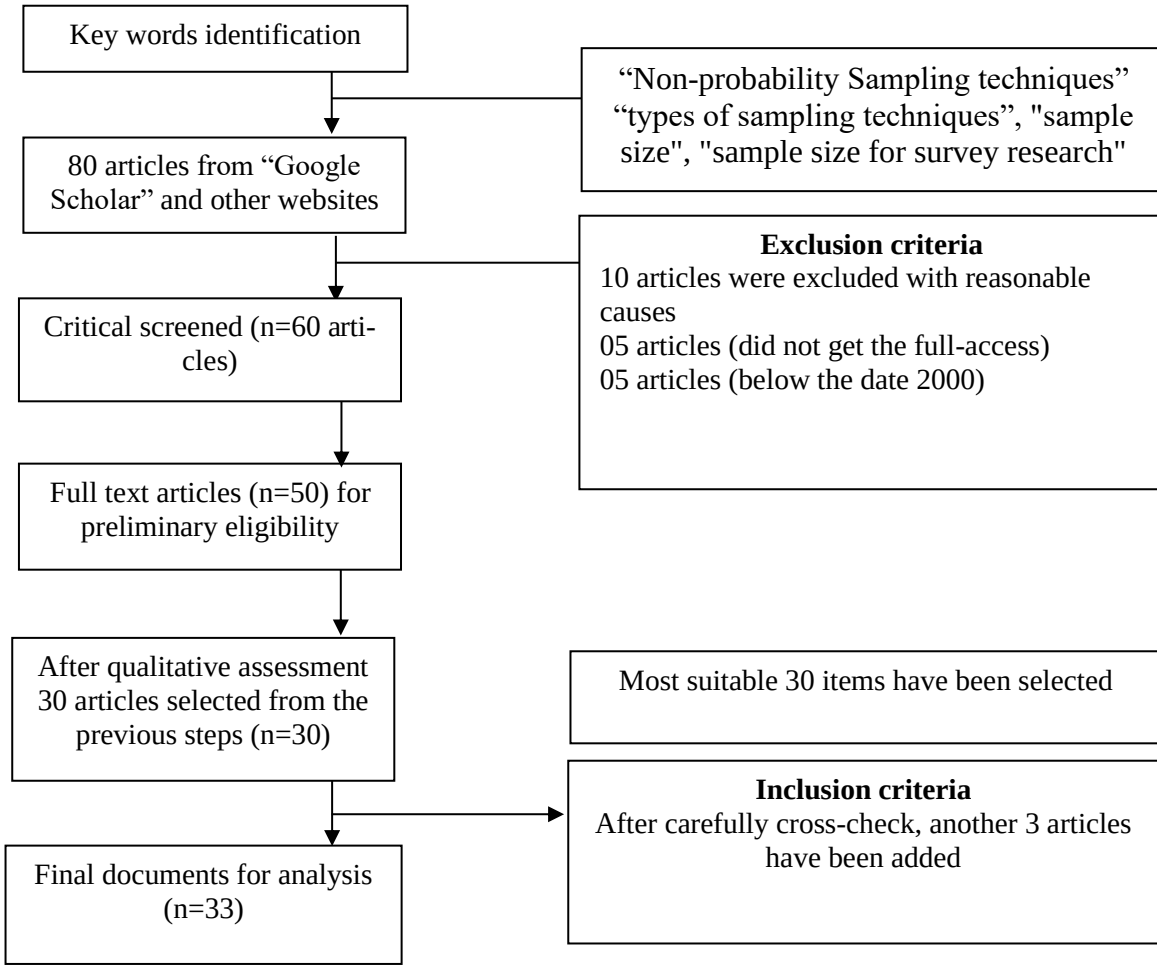


Figure 1. Sampling process

All of the duplicates have been scrutinized in great detail so that we can ensure the reliability of the study. To assure the quality and relevance of the academic literature, the abstracts of the articles were subjected to intense scrutiny. Subsequently, each research report was subjected to a thorough analysis before being deemed complete. A review was conducted on 80 papers, of which there were no duplicates. Articles with pertinent information and illustrations that met the purpose of this review were selected for inclusion; all other articles were not considered for inclusion due to the nature of this study, which is a narrative review. The researchers settled on covering the years 2000-2022 for their research. On the other hand, the vast majority of the publications published before 2000 were excluded from the search. In addition, after applying the inclusion criteria, purposive sampling was used to eliminate duplicate records. Then, 3 additional articles were added to the study because they were the most relevant to this study; however, they were published before 2000. Ultimately, the researcher chose 33 documents (n=33) based on the inclusion and exclusion criteria. The authors' conceptual definitions of sampling techniques and the benefits and drawbacks associated with each were supported by literature, which the researchers gathered from a total of 33 papers. On the other hand, all of the mentioned examples come from the researchers' personal experiences.

Research question one: What stages does a researcher need to follow to select a suitable sampling technique?

Sampling technique's stages

Before selecting the most suitable sample techniques, it is necessary to have a solid understanding of the phases involved in the sampling process. In most cases, to choose the appropriate sampling technique, the researchers need to concentrate on the factors listed below (Table 1).

Table 1. Basic concepts of sampling stages with example

Sampling stages	Concepts	Example
Clear idea about target population	The term "target population" refers to a group of people or things about which researchers wish to draw generalizations in their findings. Under certain conditions, a sample represents a group of people who collectively make up what is sometimes called a "target population."	A researcher wants to know the entrepreneurial intentions of undergraduate students of higher education institutions in Bangladesh. In this particular situation, all of the undergraduate students will be considered "target population".
Choosing the Accessible sampling frame	A sampling frame is a list of all possible units to sample from a population. Remember that a population is broader in scope while a sample frame is more specific.	In relation the above example, if that faculty member decided to collect the data from only 15 higher educational institutions, then, the undergraduate students of those 15 higher educational institutions are accessible sampling frame.
Choosing sampling techniques	***This part will be covered by answering the second research question.***	
Consideration of the appropriate sample size	***This part will be covered by answering the third research question.***	
Implementing the sampling plan including data collection	In this stage, the researchers have to select a suitable sampling technique based on your problem statement, research questions and objectives.	After considering all of the above issues, if that researcher, can collect the from 400 undergraduate business students from those 15 higher educational institutions using "stratified sampling technique).

Research Question Two: What are the various non-probability techniques?

Sampling techniques

Sampling strategies are very important in a variety of different kinds of experimental research, including the social sciences (Suresh et al., 2011). The two most common methods of sampling are known respectively as probability sampling and non-probability sampling (Rahman et al., 2022; Elfil and Negida, 2017; Shorten and Moorley, 2014). In this paper, the researcher only focuses on non-probability sampling techniques.

Non-probability sampling

When there is no equal chance to select the respondents for the study, it is suggested to use the non-probability sampling technique. Non-probability samples can typically be obtained in a shorter time and for a lower financial investment than probability sampling techniques. However, these inference methods can be influenced by selection bias; it is impossible to use them to estimate population sizes in a manner that is near to unbiased. In addition, considering that these techniques depend on the researcher's discretion or a random event, it is often not possible to use them to draw broad generalizations for the entire society. The common techniques of non-probability sampling are describing below with appropriate example.

Table 2. Non-probability sampling techniques with its uses and example

Non-probability sampling techniques	***When to use***	***Example***
Convenience sampling	This technique is excellent for young researchers like new teachers who cannot move freely from their institutions (Statistics and Theory, 2020). This method works best when the people are very diverse and can live anywhere (Alvi, 2016). Also, this strategy saves time and money, both essential factors (Taherdoost, 2016). Convenience sampling is typically favoured by researchers in the beginning phases of survey research since it is quick and straightforward to collect findings. Although there is considerable resistance among statisticians to employing this method, it is essential whenever there is a need to get insights in a short amount of time or without making a big financial commitment.	*A social science researcher needs to get feedback from 400 undergraduate students about their entrepreneurial intentions. In that case, the researcher can prepare a questionnaire and distribute it to the undergraduate students. Or, he or she may quickly create an online survey and send a link to all social media. This is an example of convenience sampling.*
Purposive sampling	Purposive or judgmental sampling is a type of sampling that researcher's use when they want to find people with certain traits that are important to the study. People who took part in the research could give a lot of information about the research question, even though it is unlikely that the sample will be representative of the whole population (Acharya et al., 2013; Lohr, 2009). Purposive sampling is best or most effective in terms of research in conditions where there are just a confined number	*In relation to the earlier example, if the researcher needs the data from senior-level undergraduate students to fulfil the research objectives, he or she might purposively select the students to form 4th-year final students as they might have experienced about entrepreneurship and entrepreneurship education.*

	of individuals in an all-inclusive community who own characteristics that a specialist anticipates from the objective individuals.	
Quota sampling	Under this sampling technique, the researchers select the necessary sample size from each population's sub-group by following a proportionate ratio (Pace, 2021; Iliyasu, 2021). When the accuracy of the research outcome is less critical, the quota sampling method is more appropriate. Quota sampling is effective when the researcher has a clear concept of the research purpose and in-depth knowledge of the population. Besides, when conducting research that requires a comparative examination of two subgroups, quota sampling identifies distinct characteristics among the interrelated traits of those two categories.	*In relation to the earlier example, the faculty member needs 40% female and 60% male students. So, based on the proportionate quota sampling, the required sample size will be, Female: 40% of 400= 160, Male: 60% of 400=240. The total sample size will be (160 female students+240 male students=400 students).*
Snowball sampling	Snowball sampling is all about networking. It has evolved over the years into a method that can be used to research populations that are difficult to access or even concealed (Heckathorn, 2011). Not only is it a tool to explore the network, but it is also a practical approach to getting in touch with respondents without their awareness. The success and efficiency of the snowball sampling approach, on the other hand, are almost totally contingent upon the personal or professional contacts of the researcher (Waters, 2015).	*Concerning the earlier example, if researcher needs the data from senior-level undergraduate students to fulfil the research objectives, he or she might send the questionnaire only to the representatives of the batches, and the representatives may forward the questionnaire to his or her known students. During the distribution, the representatives will instruct other representatives to distribute the questionnaire to their known students. This procedure will continue until getting the 400 responses from the respondents.*

Research question three: What is the minimum sample size for survey research?

Determination of sample size

For survey research, sufficient sample size is crucial. Without ensuring a sufficient sample size, it is difficult to generalize the findings of research. According to Sekaran and Bougie (2010), the sample size is the portion or sub-set of a population required to ensure that there is sufficient information to generalize the findings of the research. Several factors need to be considered when choosing an appropriate sample size such as budget, time, number is items, the number of variables, the complexity of the research model and so on. In the following part, the general guidelines relating to the calculation of sample size are given. In the first stage, the researcher has shown the sample size calculation using G* power software. In the second stage, sample size calculation for continuous and categorical variables has shown. Finally, some popular techniques for the determination of sample size have been shown as a Table 3.

*Sample size calculation procedure using G*power*

Apart from the above methods or techniques (mentioned in Table 2), one of the most popular ways to calculate the sample size is G*power. The overall procedures and commands of G*power are shown step by step.

1st step: The researchers have to download the free G*power programme (17 March 2020 - Release 3.1.9.7) using the following link http://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologieund-arbeitspsychologie/gpower.html

2nd step: When the programme is ready to use, selecting *"F tests" analysis from the test family options is required.*

3rd step: From the statistical test, select *"Linear multiple regression: fixed model, R2 deviation from zero."*

4th Step: In the power analysis option, *"A-priori: Compute required sample size – given α, power and effect size."*

5th Step: The researchers need to input "*effect size at 0.15 (medium effect), α at 0.05, and power at 0.80" in the input parameters.*

The above five steps are the most common recommended settings for business and social science researchers (Hair et al., 2017). Afterwards, the researchers must depend on the predictors of their research model indicated by arrows to the dependent variable. An example of a simple research model is given below to identify the predictors.

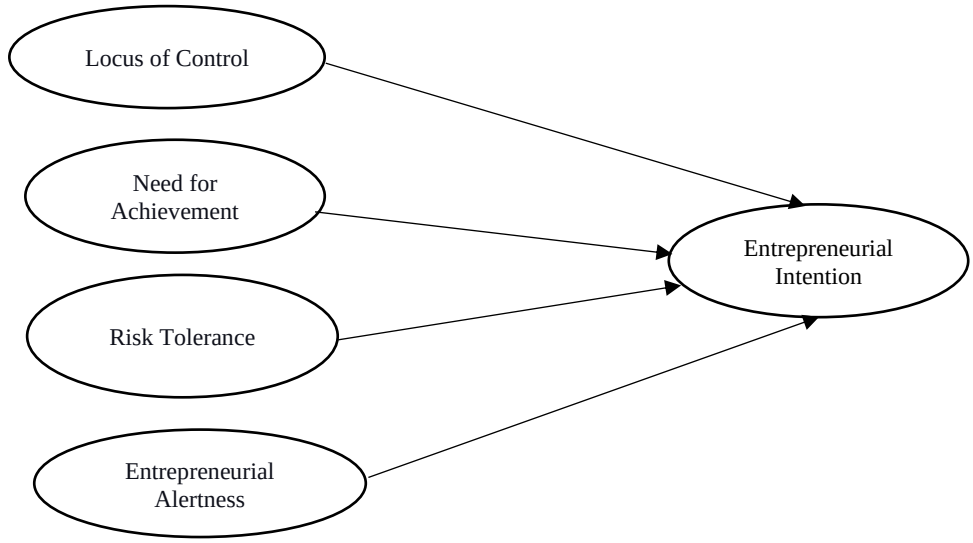
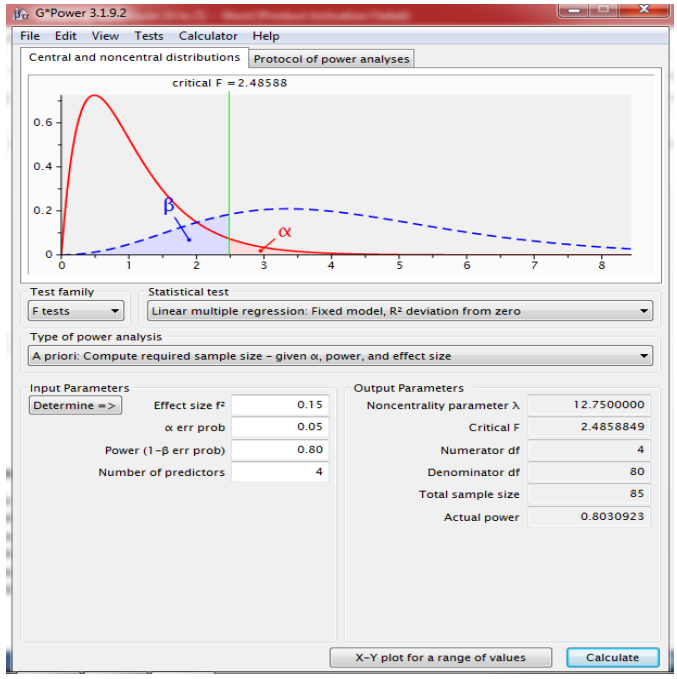


Figure 2. Dummy research model to find out the predictors and arrow to dependent variable

From the above dummy model, the number of predictors is 4, pointing to the dependent variable. Then, the researchers need to input these 4 predictors into the "number of predictors".



Source: Screenshot taken by author

For simple research model (figure 2), ***the minimum sample size is 85.***

The below model is complex, 4 as the direct predictors and another 4 (independent*moderating) as the indirect predictors, so the total predictors are 8 that pointing the dependent variable. Then, the researchers need to input these 8 predictors into the "number of predictors"

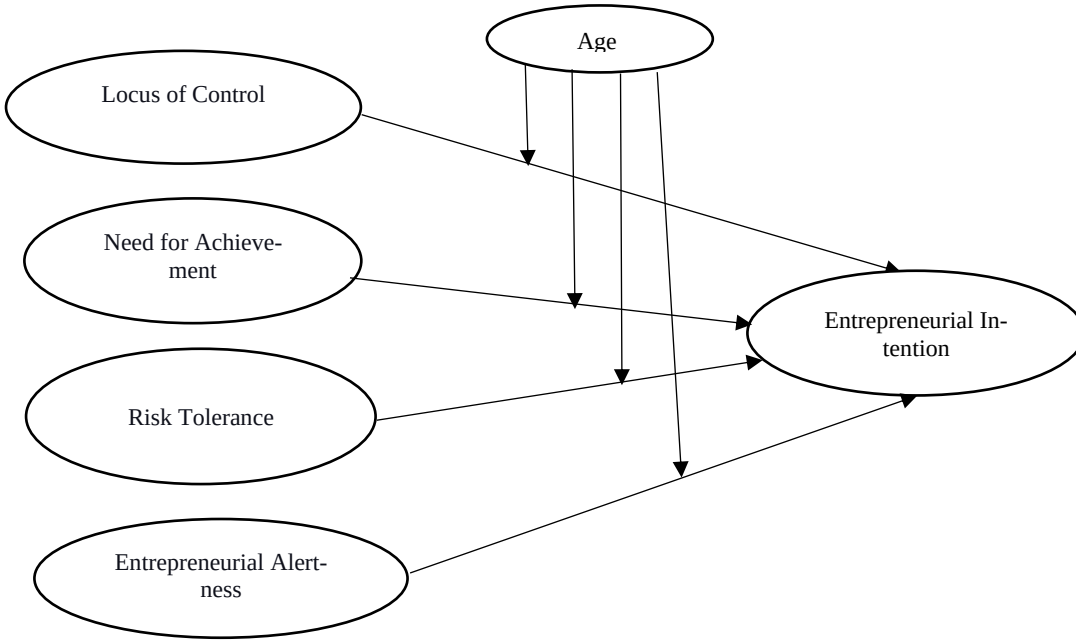
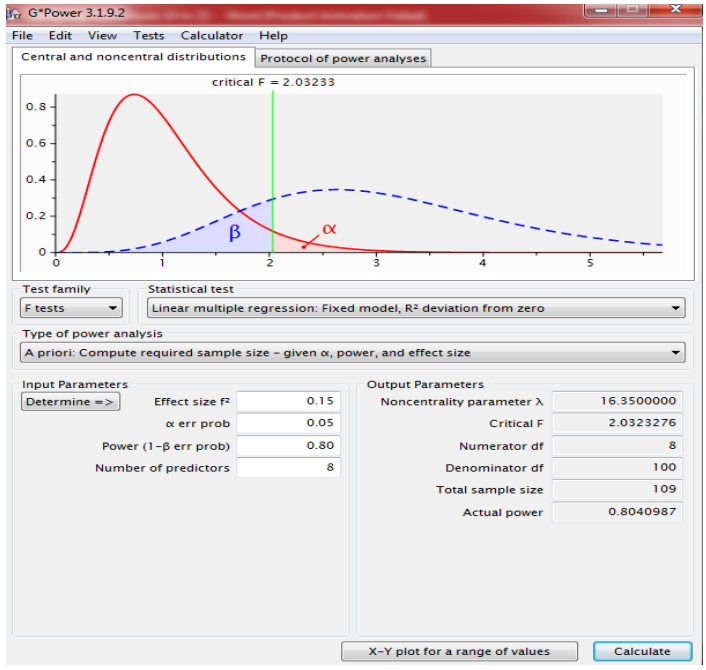


Figure 3. A dummy complex model (moderation)



Source: Screenshot taken by author

In that case, it was a complex research model, thus, ***the minimum sample size is 109.***

Sample size for continuous and categorical variables

Before determining the sample size based on continuous and categorical variables, there are several factors that need to be considered, such as a) selecting the alpha value, b) the acceptable margin of error of mean being estimated, and c) the estimate of variance of population. These are just a few examples (Cochran, 1977).

First, according to Bartlett et al. (2001), an alpha level of 0.05 is acceptable in the majority of research; therefore, an alpha level of 0.05 (t value of 1.96), which represents a 95% confidence level, has been established.

Second, the margin of error is the range of mistakes that can be made in a study. Krejcie and Morgan (1970) say that for continuous data, a margin of error of 3% is acceptable. But since the research tool for this study was a 5-point Likert scale and the acceptable margin of error is 3%, the true mean of the 5-point scale will undoubtedly be within ± .15 (0.03*5). But the acceptable margin of error for categorical data is ± 5.

Calculating the estimated variance is the third and final factor to consider. Since it was established earlier that the present investigation utilized a scale of the Likert variety consisting of five levels, the calculation of variance would be 4/5, with 1.25 representing the square number. Where 5 represents the total number of points on the scale, and 4 represents the amount of standard deviation that may be calculated by subtracting one from the total number of points on the scale.

On the contrary, with a view to getting maximum sample size for categorical data, Krejcie and Morgan (1970) suggested a variability of 50% in the population, thus, the categorical data might be squaring the population variability $(0.50)^2 = 0.25$.

Formula for Continuous Variable, $N_0=t^2*s^2/d^2$

Formula for Categorical Variable, $N_0=t^2*pq/d^2$

Here

t= selected alpha level

s= estimated standard deviation

d= Acceptable margin of error of mean being estimated

pq= estimated variance

p= Proportion of maximum possible population

q= 1 minus possible population proportion.

Sample Size for Continuous variable, Cochran's (1977) using $N_0=t^2*s^2/d^2=$ 267

Sample Size for Categorical variable, Cochran's (1977) using $N_0=t^2*pq/d^2=$ 385

Now in the following Table, the researcher has highlighted some popular guidelines for the determination of minimum sample size for survey research.

Table 3. Sample size guidelines for survey research

Approaches	General rules	Example for minimum sample size
Sample to variable(s) ration	Considering the sample to variable ration, the ratio should not be less than 5:1, but a 15:1 or 20:1 ratio is more preferable (Hair et al., 2018).	If a researcher developed a model with 6 independent variables, the sample size is 6*5=30!!!! This sample size is insufficient for inferential analysis (Bartlett *et al.*, 2001). In that case, the researcher must go for a 20:1 ratio; ***then, the minimum sample size will be 6*20=120.***
Sample to item(s) ration	The first common rule for an item to ration is that the ratio should be at least 5:1. (Suhr, 2006). Another rule is, the ratio should be 20:1 (Liao et al.,2015; Yeoh et al., 2016 and Forsberg & Rantala, 2020).	If a researcher focuses on 50 items in his or her questionnaire, ***the minimum sample size will be 50*5=250*** If a researcher focuses on 30 items in his or her questionnaire, ***the minimum sample size will be 30*20=600***
Sample size from the Table of Krejcie and Morgan's	Social science and behavioural researchers widely use the Krejcie and Morgan Table (KMT, Krejcie & Morgan, 1970) to determine sample sizes. This information can be used without calculations and applies to any specified population. According to the KMT, a sample size of 384 is enough for a population of 1000000 or more.	***A sample size of 384*** is sufficient for a population up to 1000000. If the population size is less than 1000000, one can visit the following link to get the minimum sample size http://www.kenpro.org/sample-size-determination-using-krejcie-and-morgan-table/
Sample size for CB-SEM as per Kline's (2005, 2016)	Covariance Based-Structural Equation Modeling (CB-SEM) is a widely used statistical technique for social science researchers. The sample size for CB-SEM depends on the researcher's model. If the research model is not too complex, 100 respondents are a small sample size, 200 respondents are a medium sample size, and over 200 is a large sample size (Kline, 2005). However, Kline (2016) also stated that a	***100 to 200 sample size*** is enough for a simple research model with normal data distribution. ***Over 200*** is suggested for a complex model with a non-normal distribution of data.

200 sample size is insufficient if the research model is too complex with a non-normal distribution.

Sample size guidelines for PLS-SEM

Business and social science researchers also use the Partial Least Square-Structural Equation Modeling (PLS-SEM) techniques for their studies. The "10-times rule" was initially developed by Hair, Ringle, and Sarstedt (2011). The prior literature has extensively used it since it is the most simple and straightforward method to determine the sample size than other methods (Westland, 2010; Kock & Hadaya, 2018;). The determination of the sample size using the rule that the sample size should be greater than 10 times the maximum number of inner or outer model linkages pointing at any latent variable in the entire model. According to Kock & Hadaya (2018), the "10-times rule" method for finding the smallest sample size frequently gives wrong estimates. Hair et al. (2014) came up with a different way to find the minimum sample size than the "10 times rule." Kock and Hadaya (2018) called it the "minimum R-squared method" because it uses the model's minimum R2. This method, in particular, is based on Cohen's (1988) power Table for least squares regression and the three criteria needed to figure out the sample size. The first part of the minimal R-squared technique is the number of arrows that point to a latent variable in a model. The second part is the significance level that was used, and the third is the minimum R2 of the model. Table 01 is a shortened version of the Table published by (Hair et al.,2014).

Suggested sample size

Maximum number of arrows pointing at a construct	Minimum R^2 in the model			
	0.1	0.25	0.50	0.75
2	110	52	33	26
3	124	59	38	30
4	137	65	42	33
5	147	70	45	36
6	157	75	48	39
7	166	80	51	41
8	174	84	54	44
9	181	88	67	46
10	189	91	59	48

Source: RVSPK Ranatunga et al., 2020

	It uses the most common significance level of 0.05 and assumes that the power is set to 0.8.

Implications

This study provides an essential and easily digestible explanation of selecting an acceptable sample size and non-probability sampling methods utilized in research. Each type of non-probability sampling approach possesses a one-of-a-kind combination of characteristics, advantages, potential disadvantages, and examples of applications. At the study's beginning, the sampling method and the reasons behind it are discussed. The readers will observe that non-probability techniques have been explicitly covered under distinct titles when they read this study from beginning to end. Additionally, examples that are quite similar to these are used in discussing the different non-probability sampling techniques, with a few minor modifications. This section's goal is to dispel any misconception about the non-probability sampling techniques that appear to be comparable. In addition, this study has explored several guidelines for determining the right sample size for surveys. G* power model, sample size of categorical and continuous variables, the sample to items ratio, the sample to variables ratio, and the sample size of the corresponding CB-SEM, PLS-SEM are included in these guidelines.

Conclusion

This paper focuses on two main goals: first, to get an idea of the minimum sample size for survey research, and second, to explain non-probability sampling techniques and give an example of how they work. If the researchers do not use the proper sampling method and do not take a significant enough

sample, they will never be able to reach their research goals. There are a lot of different non-probability sampling strategies, so the researcher needs to know how they differ to choose what is best for their studies. Also, a few rules or guidelines must be followed when deciding the minimum sample size for survey research. These guiding principles could make it easier for researchers to generalize the results of their findings. Researchers will benefit from this study because it will help them choose the accurate non-probability sampling method(s) and minimum required sample size for their studies.

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Md. Mizanur Rahman is currently working as an Assistant Professor, BRAC Business School, BRAC University, Bangladesh. The research interest areas of Rahman are Management, Organizational Behavior, HRM, Entrepreneurship, Artificial Intelligence, Corporate Governance, and Sustainability. Dr. Rahman is more focusing on quantitative techniques following PLS-SEM, CB-SEM, and SPSS.