Sampling Techniques and Survey Methods in Election and Opinion Polling

1 Introduction

The way that polling organisations select individuals for polling surveys is through the technique called sampling techniques. Sampling techniques are fundamental tools in election and opinion polling. It can only select a small group of people; however, the result from a small group of people can represent the opinion of the total population [11]. The polling organisation used this method for a long period to reduce the cost and time needed to conduct the polling survey [9].

This report will focus on the background, theory, and application of sampling techniques to election and opinion polls. It will also introduce some techniques that are commonly used for election polling sampling while explaining the benefits and challenges of each method. This is followed by an analysis of the data from the "An Evaluation of the 2016 Election Polls in the United States" and "How Public Polling Has Changed in the 21st Century" articles to understand the proportion of sampling methods that were used, the trend of changing samplings and survey methods, and the factors that might affect to changing samplings and survey methods that are used for polling today [3, 4]. Ending by the conclusion of the report, the challenges of these techniques and recommendations for future works.

2 Background of Sampling Technique

Sampling, a technique for statistical analysis with a rich historical background, is mentioned several times in the Bible. Its significance was further underscored in the 18th and 19th centuries, with Pierre Simon Laplace using sampling methods to estimate the population of France in 1786 [10]. Moreover, Alexander Ivanovich Chuprov brought the sampling technique to Russia in the 1870s. This technique is used to select a subset of individuals from the population to estimate the characteristics of the entire group [10].

The two main advantages of using the sampling technique are that it speeds up the data collection process and lowers the project's cost [10]. However, it is crucial to note that the sampling method only estimates the result, and the most accurate result will come from examining every individual [9].

The previous paragraph showed the advantage of the sampling technique, so it could

be helpful to use this technique in other fields when observing the data. Fields like business, medical research, and agriculture use sampling methods for practical and efficient population analysis [10]. Thus, the techniques used to sample the sample population are important in election and opinion polling to ensure the accuracy and reliability of the results.

3 Theory of Sampling Technique

The sampling technique is a crucial technique used by researchers to gather data efficiently without needing to observe every individual in a larger population [6]. It selects the small group that could represent the larger group, ensuring that this smaller group can accurately reflect the characteristics of the entire group [9]. For instance, a researcher would like to choose 100 college students from 1,500 to test their physical fitness to find the result from sampling that can cover all 1500 students. This approach is essential because it could reduce the cost and time consumption or reduce the challenge of testing everyone [9].

The sampling techniques are divided into probability sampling and non-probability sampling. The critical difference between these two types is that probability sampling provides a fair chance for every object to be selected, which makes the result more accurate and reduces the bias for the whole population. In contrast, non-probability sampling does not give everyone a fair chance and might lead to a biased result [11]. However, it is the way that is quicker and reduces the cost. The details of each probability type of sampling will be provided in the following paragraph.

3.1 Probability sampling

Probability sampling, also known as random sampling, is a method in which each individual in a population has an equal chance of being selected [6, 9]. This is often done by making a list of everyone in the group setting as a sampling frame and then randomly selecting people from the list using a computer [11]. This method could be the fairest way to choose the people that might provide an unbiased result. However, it may take a lot of time and effort to confirm the accuracy of the result [6]. The five core standard techniques that are used for probability sampling to select a sample for the election opinion poll are simple random, stratified, cluster, systematic, and multistage sampling, which will be summarised in the short concept below [6, 9].

- **Simple random sampling:** This method is the equal-chance selection method by randomly selected people as sample. Offering the fair and straightforward way to create the representative sample.
- **Stratified sampling:** This method is diverse the population into the subgroups and randomly sample from each subgroup to ensure that sample could representation of all groups member.
- **Cluster sampling:** This method is dividing the population into groups and randomly select the entire groups to form the sample.
- **Systematic sampling:** This method is selecting every nth individual from the population staring from a random point, with the interval of selection determined by the size of population divided by the desired sample size.
- **Multistage sampling:** This method is quite similar to the cluster sampling but more step of selection by selecting the large clusters first, and then randomly select the individual in those cluster.

The five techniques of probability sampling have been introduced above, with the core concept of all techniques being that the probability that people are selected as samples is equal [9]. All these probability sampling techniques could be used as the basis of sampling techniques for selecting samples to do election or opinion polling, such as Random Digit Dialling (RDD) or Registration-based sampling (RBS), which will be explained in detail in the section on **the application of sampling techniques to election and opinion polling**.

3.2 Non-probability sampling

Non-probability sampling is a method in which all individuals from the population do not have an equal chance of being selected as a sample. This technique includes various strategies for selecting the sample [2]. For example, convenience sampling, in which the sample is selected based on availability; quota sampling gives the quota of participation to the specific group. These strategies are based on the theory that populations do not have an equal chance to select as a sample [11]. This sampling technique could benefit from being less costly and quicker than probability sampling; however, it could provide a higher risk of biased results, and the result cannot represent all of the population's opinions [9, 11].

4 The application of sampling techniques to election and opinion polling.

The method of selecting people to answer the election and opinion poll is based on the theory of scientific sampling methods provided in the theory section, which could be said to be the process of selecting respondents randomly to ensure that the sample collected can cover the results of all populations. The American Association for Public Opinion Research (AAPOR) said that polling all voters in the USA from 145 million registered voters to predict the election vote result is impossible because of the large amount of population; it might be better to use the method of sample selection process instead of understanding just only a sample that could reflect the broader view of voters [1].

The polling organisations in the USA have been using different sampling methods as the base to randomly select the respondents to do the poll, which can be separated into three main types: probability sampling, non-probability sampling and the combination of probability sampling and non-probability sampling technique [1]. Probability sampling techniques have been used to randomly pick people to do the poll for over 50 years. However, nowadays, because of the cost of processing the probability sampling and the fewer people to answer the poll, the researcher desired to change the method to non-probability sampling so that the sampling is not randomly selected. However, it can be done by volunteers [1, 2]. For example, asking people's opinions from the online platform, so people willing to answer the form might join in answering.

The AAPOR has said that the way of using non-probability sampling today could give a good result or might be better than the old random technique (probability sampling), especially in predicting who wins elections [1]. Moreover, it can still reduce the cost and time needed to process the sampling. However, it needs to be careful of the results from the non-probability sampling technique that could lead to bias or not covering all of the population results because some people who volunteer to do the polls might only cover some of the results that should [2]. Thus, it has been an evolution of a new sampling technique, which is the combination of probability sampling and non-probability sampling technique. This new method could bring the advantage of combining two methods that can reduce cost and time but still get the random sampling.

The following section will introduce the specific techniques that are commonly used to sample the population for elections and opinion polls. These techniques are divided into three main sections: probability sampling, non-probability sampling and the combination of probability sampling and non-probability sampling techniques.

4.1 Probability sampling techniques in election and opinion polling.

As mentioned before, in probability sampling that is every person in the population has a chance to be included in the survey; the main benefit of this method is that the sample can represent the total population and it can calculate the margin of sampling errors of the result, which suggest how much the result from sampling is different from the total population [7]. The common methods in which polling organisations are used to select people based on probability sampling are Random-Digit Dialling (RDD) and Registration-based sampling (RBS) [1, 7].

4.1.1 Random-digit dialling (RDD) sampling

Random-digit dialling (RDD) is a probability sampling technique for telephone surveys in which the telephone numbers are randomly generated and chosen [1]. To elaborate on the use of RDD in US phone numbers, the phone numbers in the US have 10-digit numbers that are divided into four sections: country code, area code, exchange code, and personal number, which can be seen in the structure in Table 1. The first three parts of the phone number are based on the geographical location, and the last part is generated randomly based on the probability sampling theory [7].

Table 1: The explanation of the format of the US phone number.

The USA telephone number: (+1) 907 444 200 1234			
Country code	**The area code**	**The exchange (city) code**	**The specific device number**
+1 = location number of the US	415 = Example of Alaska area	200 = Number of Valdez city	1234 = Personal number

To process the RDD samplings, the first three parts of location numbers are selected, and then the four digits are added to make the whole number randomly based on the probability sampling theory, ensuring that every individual has an equal chance to select [7]. This random process must ensure that the numbers that do not work or the business numbers have been removed to reduce the time and cost of spending on the inactive numbers.

The advantage of this method is that people have an equal chance to select their phone number, and it is an easy way to reach people by phone to conduct the survey. However, it still has some limitations due to the cost of telephones, and it wastes time to call some of the telephone numbers that do not work. Moreover,

it takes a lot of time to make the interview by pollsters to ask the respondents on their own [1, 7]. Additionally, the pollers need to verify the selection process; if the same household members are selected, the random selection of only one result from them needs to get a fair vote sample [1].

4.1.2 Registration-based sampling (RBS) sampling

This process also uses the telephone to conduct the polling survey, which is the same as the RDD sampling; however, it is different. The process starts by randomly selecting people from the registered vote list who already provided valid cell phone numbers. This method could save more money and time because most calls could be reached on the working number, unlike RDD [1]. However, this method still has some limitations in that sometimes the voter lists may not cover all of the necessary details or cover the actual phone number. For example, people who registered on the voter list sometimes may provide their house or business number instead of their cell phone(private) number. Moreover, the list of registered voters might not include the people who have recently moved in or just signed up to vote [1].

4.1.3 Probability-based panels sampling

Probability-based panels are survey panels where participants are selected through random sampling methods. Each member has an equal chance of being selected and included in the panel. This sampling could ensure that the sample can cover the entire population [4].

4.1.4 Address-Based Sampling (ABS)

Address-based sampling is the probability sampling method used to sample postal addresses in the US. The addresses are randomly sampled from the database gathered by the U.S. Postal Service (USPS), which might cover nearly all of the US households, including all 158 million business and residential addresses [8].

4.2 Non-probability sampling techniques in election and opinion polling.

This technique is used to select the sample. However, it does not guarantee that everyone has an equal chance to be chosen for the survey based on the theory of non-probability of sampling techniques mentioned in the previous section on the

theory sampling technique [1]. This method is an easy and simple way for all the population to participate in the polling survey. The people who join this type of survey could be volunteers. For example, people are willing to take opinion polls after seeing them through the online platform, which could be done through an online form like Microsoft Form, which could be an easy way to record and analyse the results later by polling organisations. However, this technique may lead to a biased sample because results are only obtained from the people who choose to take the survey. In contrast, those who did not take the survey might think differently, which could lead to a biased result and the result from the sample not representing all of the population [1]. Additionally, this technique does not have a simple way to calculate the margin of error of the prediction result. The prediction error needs to be calculated by the estimators, who require statistical models, which might be challenging [1, 2]. The non-probability sampling technique, which is commonly used for the selected people to do the opinion polls, is Self-Selected Sampling (SSS).

4.2.1 Self-Selected Sampling (SSS).

Self-selected sampling is a method that people can choose to participate in to respond to the polls or not on their own. These polling surveys can be conducted through various methods, such as dial-in, social media, or online polls. The most common trend that polling organisations select to use is online-based polling surveys (online opt-in). Thus, this self-selected sampling method is not random sampling; everyone does not have an equal chance to do the poll [1]. Thus, this method could lead to self-selection bias, which the AAPOR said that bias could lead to unreliable results of the polling survey because the sample cannot cover the results of all populations making the error in prediction. However, the poll sometimes might give us an accurate result; it is quite challenging to tell that the sample of this technique can cover the entire population [1, 5].

4.3 The combination of probability sampling and non-probability sampling techniques.

This technique occurs when the polling organisation wants to combine the advantages of both probability and non-probability sampling techniques to provide an efficient sampling method. The commonly combined two techniques used for polling are known as the Interactive Voice Response (IVR).

4.3.1 Interactive Voice Response (IVR).

This method is the combined method of probability sampling, which is Registration-based sampling (RBS), with the non-probability sampling technique, which is self-selected sampling (SSS) through online-based sampling (online opt-in) [3]. This method could allow the pollster to target a specific demographic or voter group more precisely than random digit dialling sampling because the RBS can ensure that the sample includes registered voters. This method conducts the poll survey by using the RBS to dial the numbers of people who registered on voter lists; moreover, the online samples can include people who are hard to access by phone number, giving the opportunity to do the poll by online platform. Thus, this method could cover a broader demographic of the sample that could receive the sample's response in two ways: saving the cost and the time of polling organisations to conduct the survey method [3]. However, it still needs to take care of the results from the online opt-in, which is a non-probability sampling that could lead to biased results.

5 The analysis of sampling techniques and surveys for election polling.

This part will focus on the analysis of the data obtained from the research and article of Kenedy that is "An Evaluation of the 2016 Election Polls in the United States", to understand the proportion of sampling and survey methods that have been used in the 2016 election polls in the US [3]. Analyse the data from the 2016 polling survey to understand how selecting the survey or sampling methods might affect the accuracy of predicting the wrong result in 2016 election polls in the US.

Moreover, it will focus on the trend of polling organisations changing the methods of sampling and surveys between 2016 and 2022. Through the data from the article of Kenedy, "How Public Polling Has Changed in the 21st Century". The result from Kenedy's article suggests that 61% of the national pollsters in the US have been changing the method of survey and sampling since 2016 [4]. Thus, this report will analyse the trend of change in each sampling and survey method from 2000 to 2022 and provide the information to answer the question of why the polling organisation has a high changing rate of the method of survey and sampling.

5.1 Analysis of the 2016 Election Polls in the United States.

Based on the report "An Evaluation of the 2016 Election Polls in the United States" wrote about the big questions about the accuracy of the polls that most predictions

heavily predict that Hillary Clinton will win. However, Donald Trump ended up winning, leading many people to think that polling was wrong [3]. This report will be analysed through the evaluation of the 2016 election polling results and focus on how different sampling and survey methods affect the accuracy of the poll, leading to the result being wrong.

Through the data set of 2016 Election Polls in the United States, the sampling methods used to conduct the survey are the four main sampling techniques that based to select the sample are RDD, RBS, SSS (online opt-in) and IVR, which have already been explained in detail in the section Probability sampling techniques in election and opinion polling. In this 2016 election poll in the United States dataset, the poll will be conducted using the seven primary methodologies, which are demonstrated in Figure 1 [3]. The details of the type of survey method represented in the label of the bar plot in Figure 1 are provided below.

1. Live Phone (RDD) method: Pollsters call randomly to generate the list of phone numbers (including both landslide and mobile phones), and the respondents are interviewed by the live interviewers.
2. Live Phone (RBS) method: This method is similar to the live phone RDD, but the calls are randomly dialled to the people registered on the voter registration list. Thus, the target voters are more specific in this method.
3. Internet (opt-in) method: This method is related to non-probability sampling, which is self-selected sampling(SSS), in which respondents can choose to respond to polls or not through the Internet, such as through the Internet form.
4. IVR method: The calls to voters are called by the automated system, in which respondents will listen to the question and respond by pressing the buttons on their phone keypad.
5. IVR by combined with live phone: The combination of the automated IVR call with the live interview call could provide more detailed responses.
6. IVR by combined with the Internet (opt-in): The combination of the automated IVR call with the online survey could broaden the wider sample.
7. The other method: the other method, such as surveys based on the panel that were recruited offline form a probability-based sample, like the traditional mail surveys the conducted by the Columbus Dispatch Poll.

These seven survey methods were conducted through two different polling designs. The first is the National poll design, which contains 39 data, which is used to select

the sample of individuals to represent the total population's opinion by utilising the various sampling methods and data collection to progress this design [3]. The second one is the battleground-state poll design, which contains 208 data, which focuses on the specific area or states with high competition in the election, so this area needs to be focused more [3]. That might use many methodologies to sample people to do the poll, ensuring it could cover the population's opinions. These two different poll designs were conducted within the final 13 days before the election [3].

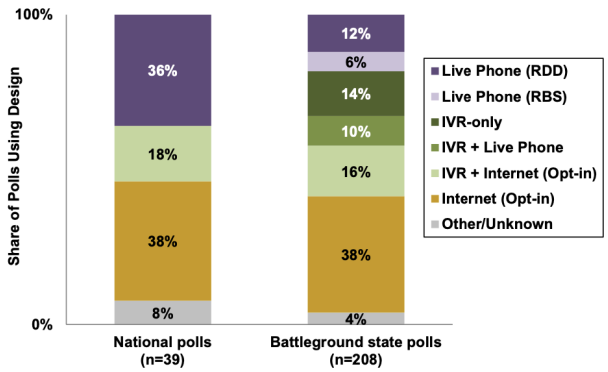

Figure 1: Comparison of polling Methods used in two different polling designs [3]

From this figure, it can be seen that in terms of national polls have been done by three main methods that are RDD, IVR combined with internet (opt-in) and internet (opt-in) only; the method most conducted are internet (opt-in) with 38 %, which is non-probability sampling, which is at least 1/3 of the entire sample in national polls. The method of Live Phone (RDD) is followed by 36

As regards Battleground state polls, the visualisation shows that the method of doing the survey has been separated into different sections due to the Battleground state polls being an area that is highly competitive, so it needs to be more careful to conduct the survey using different methods. So, the right bar chart has been separated into six main methodologies that have been used more than the nation poll two times. The most common method is also the internet (opt-in), with the same proportion as National polls at 38%. While the second has been changing to IVR combined with internet (opt-in), around 16%. The smallest proportion is the RBS method, which is done at 6%, which might be from it spending a lot of time and cost to contract the people who registered in the voter list to the live phone.

The main insight that could be obtained from these two different bar graphs in Figure 1 are:

1. **Variation in Methodology:** As mentioned before, the choice of two different designs of the survey has an effect the variation of methodology; for example, if it chooses to focus on the Battleground state poll, that needs more focus because it focuses on the area that has high competitive so the result of the prediction might be uncertain so this area might need to use various of sampling and survey methods (2 times of methods) compared to the nation polls that only focus the whole area of the US.

2. **The increasing use of the Internet (opt-in):** The most common method used in these two different designs is the Internet (opt-in), which might increase due to the emerging technology. Making this polling method more efficient could help reduce the cost and time required to conduct the survey with a high response rate.

3. **The effect of using non-probability sampling:** The method that is increasingly used in the 2016 US election polling is the Internet (opt-in), which is self-selected sampling. Everyone can volunteer to do the poll, not the randomly selected, so it would lead to a non-random result, which sometimes might lead to the wrong result, as this sampling method could not cover the entire population. For example, if the people who volunteer would like to vote for only the number 1 candidate, the result from the survey will show that the number 1 candidate will win while ignoring the idea from other populations that might be voting for another number of the candidates. Therefore, this problem could affect the accuracy of the prediction of election polling and could be one of the reasons why the 2016 election polls in the United States were wrong.

4. **The number of samples collected in this report is quite low:** the number of samples in the National polls is only 39 samples compared to the Battleground state poll, which stands at around 200 than the number of Battleground state samples poll is more the number of samples in the National polls five times. If the number of collected results from the National polls increases, the overall proportion of methods used in this design might change.

In conclusion, Figure 1 compares the national and battleground state polls conducted in the crucial final 13 days before the election. National polls show the heavy use of the internet (opt-in) and live phone (RDD), while the Battleground state polls showed a more varied approach that reflects the competitive result of this region's need to use the various survey methods to handle. The data also suggest that internet-based polling has been chosen as the best way to sample in 2016, which could be the increase in technology that makes this method more convenient. However, this internet-based polling method is non-probability sampling, which

might lead to a biased outcome, and it does not ensure that the sample can cover the entire population. This may contribute to the inaccuracies in election prediction.

5.2 Analysis of the changing trend of sampling and survey methods from 2000 to 2022.

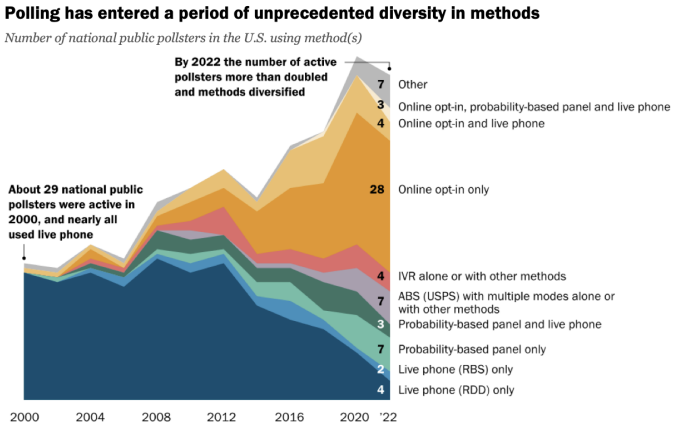

Figure 2: Evolution of polling methodologies in U.S. National Polls from 2000 to 2022 [4]

Figure 2 is an area chart that illustrates the evolution of the different polling survey methods used by national public pollsters in the US from 2000 to 2022. The important insight that can be noticed from the graph is that in 2000, 29 nations, public pollsters primarily used the live phone method to conduct the survey. Over time, the number of pollsters has more than doubled, and the variety of the methods used has significantly expanded in 2022. By 2022, the most commonly used method seems to be online opt-in, which seems to have 55 polling organisations using this method, which could make the survey easier and reduce the cost and time. Other methods used to combine online-based polling are probability-based panels (random sampling of the sample into the survey panel) and live phones.

Focusing on increasing the polling survey through online platforms seems to have significantly increased from 2000 to 2022, as shown in Figure 2; however, focusing the number of national public pollsters in the US using the online-based sampling methods paused and remained flat after 2020 could be analysed from this remaining trend because of the several factors that might be the challenges of this methodology that online based poll also have the problem of accuracy that already mention in 2016 (section of the evaluation of election polling in the USA) that the result from the accuracy of polling that predict wrong in 2016 that the problem could become form the using of online opt-in sampling that is the method of non-

probability sampling that could lead to biased and sample cannot represent all of the population. In terms of economics, the economic environment could affect the research funding and investment needed to conduct the polling due to budget limits. As regards ethical considerations, there is a need to be more cautious in the method of data collection because of the growing concern for privacy and data protection. Thus, the pause in the growth of the internet opt-in sampling method could occur due to several methods; if polling companies can not overcome all of the challenges, the trend might be flat or change to a significant downtrend in the future.

In terms of hybrid methods, the trend of hybrid methods such as IVR seems to have reduced after 2022. Additionally, the trend of probability sampling, which is Live phone (RDD and RBS) and probability-based sampling, is still used. However, it decreased to seem very low, with only six polling organisations using the live phone and only 13 polling organisations using probability-based panels compared to 2000.

5.2.1 Analysis of the proportion of sampling and survey techniques changed from 2000 to 2022.

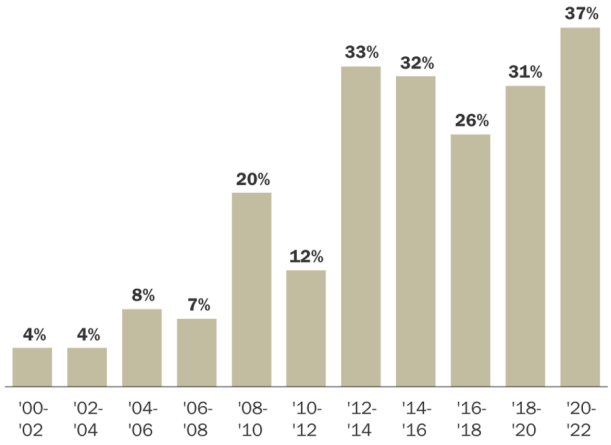

Figure 3: Changes in National Public Pollster methodologies from 2000 to 2022 [4]

The bar chart in Figure 3 represents the proportion of public pollsters that have changed their polling methods, and each bar chart represents the percentage of changes in two years. The x-axis of the graph represents the time period that data was collected and analysed from 2000 to 2022. The y-axis illustrates the percentage of the national public pollsters in the U.S. that changed the sampling or survey methods.

Figure 3 provides a lot of useful insight that could be analysed from the graph,

which shows that the trend of changing over time seems to be upward. The most significant increase of changes in the polling methods occurred in the periods after the 2016 and 2020 elections, which is the change between 2020 and 2022, with the highest proportion of changes, 37%, which is the changing of more than a third of national public pollsters changed. These significant changes could suggest that there are some problems with the method, so the polling organisation is designed to change to new ones. That might be because of the accuracy of the polling, economic problems, or ethical concerns.

5.2.2 Analysis of diversification of sampling and survey methods in the U.S. polling from 2000 to 2022.

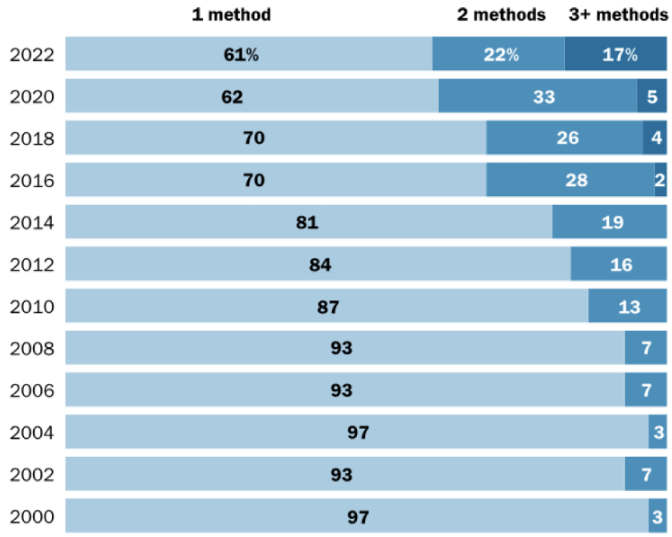

Figure 4: Trend in increasing the number of methodological diversity among the U.S. pollsters from 2000 to 2022 [4]

Figure 4 illustrates the trend of national pollsters in the US increasingly using multiple methods in surveying a sample from 2000 to 2022. In 2000, 97% of pollsters used just one method, but in 2022, this number noticeably decreased to 61%. In terms of using the two methods for conducting a survey, that noticeable rise from 3% in 2000 to 22% in 2022. Furthermore, using three or more methods is increasing from 0% in 2000 to 17% in 2022. The trend of using three or more methods might increase in the future. It could be analysed that this increasing trend of using three or more methods reflected the growing of more complexity in polling techniques and sampling in the future. That could be because the pollster wants to improve the accuracy of the polling and the sampling technique that can cover all of the population.

To conclude, the trend in the sampling and survey methods could change over a year after the wrong prediction result that suggested in 2016 that using the methods of the internet (opt-in) was the biggest proportion. That result might suggest that the use of non-probability sampling, like the internet (opt-in), cannot cover the whole population's opinion and can lead to a biased result. The fault in 2016 suggests that the changing rate of sampling and survey methods seems to have significantly increased. Moreover, the trend suggests that in the future, sampling methods might be used to combine a lot of methods to ensure the prediction's result.

6 conclusion

In conclusion, sampling techniques are the techniques used to select a small sample to represent all population opinions used by the polling organisation nowadays. The exploration of sampling techniques and survey methods in selection and opinion polling seems to be changing the trends where the traditional probability sampling, like the RDD that needs the live phone for the interview of the respondents, is instead the new non-probability sampling, such as the online survey that more easily that can save cost and times to conduct in the technology era. While these modern approaches offer the advantage of conducting the survey, however, they still some challenges for this method.

The challenge of conducting the sampling and survey to online survey, which is a popular method of non-probability sampling nowadays, is that this method leads to a result that might biased by the result of the sample from the modern method might not cover all of the population's opinion that leads to the wrong result as the election prediction in the 2016 US that the most sampling and survey methods are based to the online (modern) and it leading to the wrong result. Moreover, the result from non-probability sampling as the internet (opt-in) makes it challenging to find the margin of error of the prediction that needs to be done by the statistical models to calculate the estimated error instead.

For future work, it might be important to focus on developing the testing hybrid sampling methodologies that combine the strengths of probability and non-probability sampling as IVR methods, making it more strength to overcome the challenge of the bias of the result and improve the accuracy of prediction. Additionally, utilising the technology to help improve the efficiency of sampling methods, such as machine learning or deep learning, could provide new pathways for improving the accuracy and efficiency of the polling survey and sampling process.

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