

Learning Guide: Conducting a One Proportion Z-Test in Excel

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The [one proportion z-test](#) is a cornerstone statistical procedure used extensively across various fields, including market research, quality control, and social science. This test allows analysts to rigorously compare an **observed proportion**, calculated from a specific sample, against a known or assumed theoretical proportion belonging to the larger population. It serves as a vital tool for making reliable inferences about population parameters based on data collected through a [simple random sample](#), ultimately determining if the true population proportion significantly deviates from the value specified by a hypothesis.

To illustrate the practical utility of this test, consider a major telecommunications provider making a substantial claim: that **90%** of its entire customer base reports being satisfied with the quality of their service. To independently verify the veracity of this bold corporate assertion, an external research agency collects data from a statistically relevant sample size of 200 customers. However, upon analyzing the survey results, the researchers find a discrepancy: only 85% of the sampled individuals express satisfaction. This observed difference immediately raises critical questions regarding the accuracy of the company's initial 90% claim, necessitating a rigorous statistical investigation.

The primary goal of applying the [one proportion z-test](#) in this situation is to provide a statistical assessment of whether the actual, underlying percentage of satisfied customers across the entire population is genuinely 90%. This sophisticated analysis requires several meticulous steps, including calculating a specific numerical result known as the [Test statistic](#) (the Z-score) and subsequently comparing the resulting [p-value](#) against a predetermined **significance level** (alpha). By following this structured methodology, researchers can reach a robust, data-driven conclusion regarding the initial population claim.

The Foundational Framework of the One Proportion Z-Test

Before proceeding directly to the technical calculations or the specific functions available within Microsoft Excel, it is essential to establish a strong comprehension of the conceptual framework underlying all hypothesis testing. This methodology is systematically built upon three critical, interconnected phases: the formal establishment of the hypotheses, the precise calculation of the test metric (the Z-statistic), and finally, the formulation of a data-backed decision regarding the population claim. Adherence to these standardized steps ensures that the resulting conclusion is statistically sound and reliably derived from the collected sample evidence.

The core principle of the Z-test revolves around comparing two distinct proportions: the **sample proportion** (denoted as p , representing the observed data) and the **hypothesized population proportion** (denoted as P , which represents the theoretical claim being tested). The Z-test achieves standardization by quantifying the difference between these two proportions. Specifically, it measures how many standard deviations the observed sample proportion is situated away from

the hypothesized population proportion, under the assumption that the [Null hypothesis](#) is true. This standardized score is crucial, as it allows statisticians to determine the probability of observing results as extreme as our sample findings purely by random chance.

Step 1: Formally Defining the Null and Alternative Hypotheses

Every formal hypothesis test must commence with the precise, structured statement of two inherently opposing hypotheses. The [Null hypothesis](#) (H_0) consistently represents the status quo, the statement of "no effect," or the assertion of "no difference." It is the default position, assumed to be true unless and until the collected sample data provides sufficient, statistically significant evidence to convincingly prove otherwise. In the context of our telecommunications example, the null hypothesis posits that the company's claim--that 90% of customers are satisfied--is mathematically accurate and true for the entire population.

In direct opposition to the null hypothesis stands the **Alternative hypothesis** (H_a). This is the statement that the researcher is actively attempting to find compelling statistical evidence for--that the true population parameter differs from the value specified in H_0 . Since the initial test scenario is designed to examine whether the proportion is simply "not equal" (either higher or lower) to the hypothesized 0.90, this procedure is defined as a **two-tailed test**. A two-tailed test permits the rejection of H_0 if the true population proportion deviates significantly from the hypothesized value in either the positive or negative direction.

For the specific case analyzing the customer satisfaction rate (where the hypothesized claim is exactly 90%):

The [Null hypothesis](#) (H_0): $P = 0.90$ (The true proportion is 90%).

The Alternative hypothesis (H_a): $P \neq 0.90$ (The true proportion is not 90%).

Step 2: Calculating the Z-Statistic and Determining the P-Value

Once the foundational hypotheses are meticulously established, the subsequent crucial step involves determining the [Test statistic](#). This calculated value serves to numerically quantify the extent to which the observed sample data deviates from the expectation set forth by the null hypothesis. The mathematical formula employed for the Z-statistic within a [one proportion z-test](#) is specifically structured to normalize the inherent variability present in sampling, thereby standardizing the magnitude of the observed difference.

The mathematical formula utilized for calculating the **Test statistic**, z , is presented below. In this formula, p represents the sample proportion (0.85), P stands for the hypothesized population proportion (0.90), and n denotes the sample size (200). Calculating this standardized value is

essential as it precisely locates our sample result on the standard normal distribution curve, enabling probability assessment:

$$\text{Test statistic } z = (p - P) / (\sqrt{P(1 - P) / n})$$

Upon substituting the values from our running example into this equation, we arrive at the following numerical result:

$$z = (0.85 - 0.90) / (\sqrt{0.90(1 - 0.90) / 200}) = (-0.05) / (0.0212) = \mathbf{-2.358}$$

The resulting calculated Z-score is then utilized to accurately determine the corresponding [p-value](#). For a two-tailed hypothesis test, the p-value is defined as the total probability of observing a sample statistic that is as extreme as, or even more extreme than, the statistic associated with our calculated Z-score, considering both tails of the distribution. By consulting the standard normal distribution tables or using statistical software, we find that the [p-value](#) linked to $z = -2.358$ is approximately **0.018**.

Step 3: Interpreting Results and Drawing a Conclusion Using Significance

The final and most critical stage of the hypothesis testing framework involves making a definitive decision: whether the researcher should reject or fail to reject the [Null hypothesis](#) (H_0). This pivotal decision is governed by comparing the calculated [p-value](#) against a predetermined cutoff threshold known as the [significance level](#) (α). This alpha level, typically established by the researcher before any data collection commences, represents the maximum acceptable probability of committing a Type I error (rejecting a true null hypothesis).

Commonly accepted choices for the [significance level](#) in academic and industrial research include 0.01 (1%), 0.05 (5%), and 0.10 (10%). The decision rule is fundamentally straightforward: If the calculated p-value is less than or equal to the designated α , we are compelled to **reject H_0** . This outcome indicates that there is statistically significant evidence contradicting the null claim. Conversely, if the p-value is strictly greater than α , we must **fail to reject H_0** , meaning the data lacks sufficient statistical strength to dispute the original population claim.

Returning to our ongoing telecommunications example, let us adopt the conventional standard [significance level](#) of 0.05. We compare our calculated p-value of 0.018 against the alpha level of 0.05. Since the relationship $0.018 < 0.05$ holds true, we must rigorously reject the null hypothesis. The statistical conclusion is clear: we possess sufficient evidence to confidently assert that the true underlying percentage of customers satisfied with their service is, in fact, statistically unequal to 90%.

Automating the Two-Tailed Z-Test in Microsoft Excel

While performing manual calculations is invaluable for fully grasping the theoretical underpinnings of the statistics, employing specialized software environments such as Microsoft Excel dramatically streamlines the entire analysis process, especially when dealing with large datasets or repetitive testing. Excel provides robust built-in functions that can automate the calculation of the sample proportion, the complex Z-statistic, and the corresponding p-value, thereby significantly minimizing the potential for human computational error and accelerating the research cycle.

For the purpose of an explicit Excel demonstration, we will use a slight variation of the initial scenario: A phone company claims 90% satisfaction. A researcher samples 200 customers, and 190 reported satisfaction (a sample proportion of 0.95). The precise objective is to **test the null hypothesis that 90% of customers are satisfied against the alternative hypothesis that not 90% are satisfied, utilizing a 0.05 level of significance.**

The following visual aid demonstrates the necessary data inputs and the required formulas needed to execute a two-tailed [one proportion z-test](#) directly within Excel. It is critical to note that the three essential input parameters--Frequency (Number of Successes), Sample Size (n), and Hypothesized P (P)--must be correctly entered into cells **B1 through B3** first. These inputs then automatically trigger the subsequent calculations displayed in the output cells **B5 through B7**.

	A	B	C	D	E	F
1	Test proportion	0.9				
2	Sample size	200				
3	Frequency	170				
4						
5	Sample proportion	0.85	=B3/B2			
6	Test statistic	-2.35702	= (B5-B1)/SQRT(B1*(1-B1)/B2)			
7	P-value	0.018422	=2*NORM.S.DIST(B6, TRUE)			
8						
9						
10						
11						

The numerical outputs generated in cells **B5, B6, and B7** are entirely dependent upon the specific formulas entered into the corresponding cells **C5, C6, and C7**. A thorough understanding of these underlying formulas is paramount for accurate interpretation of the results:

Formula in cell **C5**: This calculates the **Sample Proportion** (p) using the straightforward division formula: **=B1/B2** (Frequency / Sample size).

Formula in cell **C6**: This calculates the [Test statistic](#) (z) using the standard Z-test formula: $= (B5 - B3) / \text{SQRT}(B3 * (1 - B3) / B2)$.

Formula in cell **C7**: This calculates the final two-tailed **P-value**. It utilizes the Excel statistical function **NORM.S.DIST**. Since this is a **two-tailed test**, the calculated cumulative probability for the Z-score must be multiplied by two (or use the two-tailed flag in newer functions) to account for the probability mass in both extreme ends of the standard normal distribution.

In the specific calculation depicted in the image, where the inputs yield a Z-score of 2.358, the resulting p-value is **0.018**. Since this calculated value is numerically lower than the established [significance level](#) of **0.05**, we once again reject the null hypothesis. The strong evidence suggests that the true satisfaction percentage for this modified scenario is statistically unequal to 90%.

Executing a Directional One-Tailed Z-Test in Excel

The statistical procedure requires subtle but important modifications when the hypothesis concerns directional claims, a situation typically referred to as a **one-tailed test**. Consider a scenario where the phone company asserts that *at least* 90% of its customers are satisfied. This precise phrasing alters the structure of the null and alternative hypotheses, forcing the critical rejection region to focus exclusively on only one specific side (or tail) of the probability distribution.

For this one-tailed scenario demonstration, let us assume the researcher sampled 200 customers, but only 176 responded positively (resulting in a sample proportion of 0.88). The new hypothesis structure is set as follows: ***Test the null hypothesis that at least 90% of customers are satisfied against the alternative hypothesis that less than 90% are satisfied, employing a 0.1 level of significance.***

The subsequent screenshot illustrates the meticulous setup for this lower-tail one-tailed proportion Z-test within Excel. It specifically highlights the minor yet absolutely critical difference in the P-value calculation formula when compared directly to the two-tailed test setup discussed previously:

	A	B	C	D	E	F
1	Test proportion	0.9				
2	Sample size	200				
3	Frequency	176				
4						
5	Sample proportion	0.88	=B3/B2			
6	Test statistic	-0.94281	=(B5-B1)/SQRT(B1*(1-B1)/B2)			
7	P-value	0.172889	=NORM.S.DIST(B6, TRUE)			
8						
9						
10						

As standard practice dictates, the initial input values are accurately placed in cells **B1 through B3**, and the resulting outputs in **B5 through B7** are generated automatically via linked formulas. Crucially, the formulas for the Sample Proportion (C5) and the Z-Statistic (C6) remain mathematically identical to the two-tailed test, as their function is solely to standardize the raw observed data regardless of the hypothesis direction.

Formula in cell **C5**: Calculates the sample proportion (Frequency / Sample size).

Formula in cell **C6**: Calculates the **Test statistic** (z) using the standard one proportion formula.

Formula in cell **C7**: Calculates the **P-value** for the one-tailed test. In a test specifically focused on the lower tail ($H_0: P < 0.90$), we utilize the **NORM.S.DIST** function directly, ensuring the cumulative argument is set to TRUE. The function inherently returns the cumulative probability from negative infinity up to the calculated Z-score, meaning no multiplication by two is necessary.

In this specific Excel calculation based on the inputs provided, the system yields a p-value of **0.17**. When we compare this resulting probability to our predetermined [significance level](#) of **0.1**, we observe that 0.17 is greater than 0.1. Consequently, we must **fail to reject the null hypothesis**. This statistical outcome signifies that we do not possess sufficient, compelling statistical evidence to confidently conclude that the true underlying percentage of satisfied customers is actually less than 90%.