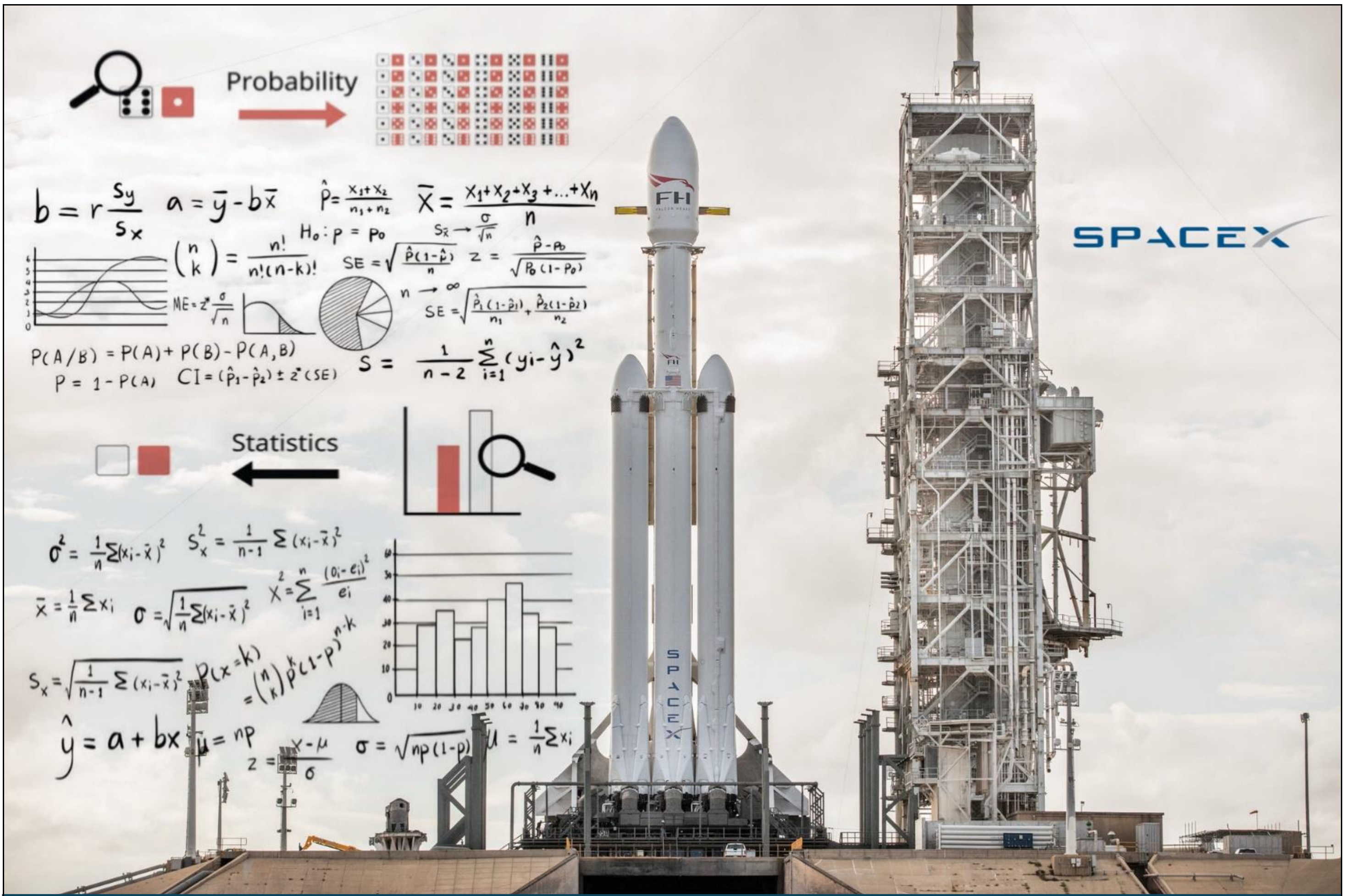

PUBLIC PERCEPTION AND AWARENESS OF SPACEX'S ROLE IN SPACE EXPLORATION AND ITS IMPACT ON FUTURE TECHNOLOGIES

PROBABILITY AND STATISTICS ASSIGNMENT **IT1212**

Submitted By,

Uthayakumar Anojan

SA23523128

1st November 2024

Student Details (Student should fill the content)	
Name	**U.Anojan**
Student ID	**SA23523128**

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Declaration			
I certify that the attached material is my original work. No other person's work or ideas have been used without acknowledgement. Except where I have clearly stated that I have used some of this material elsewhere, I have not presented it for examination / assessment in any other course or unit at this or any other institution			
Signature	U.Anojan	Date	1st November 2024 (**11:00 AM**)

Result (Assessor use only)				
Marks for the Report		Marks for viva		Final Mark
For Assessor use: Assessment feedback				
Strengths Area for improvements				
Name & Signature of the Assessor :		Date :		

ABSTRACT

The report, **"Public Perception and Awareness of SpaceX's Role in Space Exploration and its Impact on Future Technologies"** looks at how the general public perceives the company's contributions to space exploration and the potential technological advancements that could come from its ground-breaking projects. Assessing how SpaceX's reusable rocket technology, missions, and space travel vision particularly to Mars have changed public perceptions of space exploration and expectations for future developments in the space industry is the main objective.

In order to determine public awareness of SpaceX's missions, such as the Falcon 9, Starship, and Crew Dragon, as well as the perceived cost effectiveness and wider societal impacts in comparison to more established government-led space agencies like NASA, data for this study was gathered from 100 respondents using a structured questionnaire.

One limitation of the study is its small, regionally focused sample, which might not fully represent the range of global viewpoints. However, the results provide important new information about how the public's perception of private sector participation in space exploration has changed as a result of SpaceX, showing that many people believe that SpaceX is crucial to the development of space technologies and to the encouragement of private investment in the space sector.

STATEMENT OF AUTHORSHIP

I, U. Anojan, hereby confirm that the statistical study "Public Perception and Awareness of SpaceX's Role in Space Exploration and its Impact on Future Technologies" is an original creation and is solely done by myself. This statistical study contains all the ethical considerations that have been advanced by the assignment guidelines. Further, this study and the questionnaire that supports it uphold the right to privacy and confidentiality for all those who have participated in the survey. There has been no plagiarism of any kind in this research paper, the sources consulted have been duly referenced in the bibliography, along with the relevant quoted text.

ACKNOWLEDGEMENTS

I am indeed grateful and take this opportunity to extend my deepest gratitude to all those who, in one way or another, assisted me in completing this study. My deepest gratitude goes out to my lecturers at SLIIT Northern Uni, Mr. Theivendran Vigneswaran and Ms. Niroji Thayalan, for their support throughout this report with much needed guidance, constructive criticism, and materials.

I also would like to extend my appreciation to my colleagues and friends for their support and encouragement regarding this project. I would like to specially thank all the participants who spared their valuable time in answering the survey; your responses have been of immense help in collecting the data required for the research. Your contributions have made it possible to realize this research, and I value your help immensely.

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ABBREVIATIONS

SD – Standard Deviation

S^2 - Sample Variance

S – Sample Standard Deviation

H0 – Null Hypothesis

H1 – Alternative Hypothesis

$\hat{p}$ – Sample Proportion

p_0 - Hypothesized Population Proportion

f(c) – Total frequency of the specified column

f(r) – Total frequency of the specified row

n- Sample size

df – Degrees of Freedom

o_i – Observed Frequency

E_i – Expected Frequency

CHAPTER 1 – INTRODUCTION

1.1 BACKGROUND

For many years, the main forces behind space exploration have been government agencies like NASA and ROSCOSMOS. Private businesses, however, have joined the market recently, with SpaceX leading the way. SpaceX, an organization founded by Elon Musk in 2002, has transformed the space industry with its innovative plans for space exploration, such as the colonization of Mars, and the development of reusable rocket technology. By creating the Starship spacecraft for interplanetary missions and drastically lowering the cost of space travel with reusable rockets like the Falcon 9, SpaceX has upended the conventional role of government organizations and reshaped the boundaries of what is feasible in space exploration.

SpaceX's accomplishments, such as sending the Crew Dragon to the ISS and preparing for upcoming trips to the Moon and Mars, have stimulated the public's interest in space once again. In addition to establishing new benchmarks for industry innovation, these turning points have generated intense public discussion regarding the direction of space exploration and the part played by private enterprises in influencing it.

The purpose of this study is to investigate how the general public views SpaceX's contributions to space exploration and its possible influence on upcoming technological advancements. This report examines how SpaceX has impacted the public's perception of space travel and how these developments may open the door for further scientific, technological, and other breakthroughs by examining survey data.

1.2 PROBLEM IDENTIFICATION

The public's perception of SpaceX's contribution to space exploration is complicated by a number of factors such as,

1. **Awareness Levels:** Assess the level of public knowledge about SpaceX's main initiatives, including the development of Starship, the reusable Falcon 9 rockets, and the objective of colonizing Mars.

2. **Perceived Safety:** Comparing the public's perception of SpaceX's mission's safety to that of more established government space programs like NASA.

3. **Affordability Concerns:** Figuring out how the general public views SpaceX's missions' cost-effectiveness in comparison to those carried out by government space agencies.

4. **Technological Impact:** Determining whether the general public thinks that SpaceX's technological developments will lead to important advances in space travel and encourage more industry innovation.

5. **Support for Space Investments:** Determining if the general public feels that private companies like SpaceX should be allowed to invest in space exploration and whether they think it will advance technology and benefit society.

To address these challenges, a methodical research strategy is required to evaluate how the general public views SpaceX's contribution to space exploration. Through the use of structured surveys, this study seeks to shed more light on how public opinion is influenced by SpaceX's innovations and missions.

1.3 SIGNIFICANCE OF RESEARCH

In the quickly changing space industry of today, it is essential to comprehend how the public views private sector participation. With inventions like reusable rockets and bold plans for interplanetary travel, especially to Mars, SpaceX has revolutionized space exploration. This study emphasizes how the public's expectations for technological advancements and the future of space exploration are increasingly being shaped by private companies. This study attempts to offer useful insights for both private businesses and space agencies by assessing public awareness and attitudes. The results may serve as a guide for tactics aimed at boosting public acceptance and comprehension of the advantages of private sector investment in space technologies.

The importance of this research resides in its capacity to influence future investments in space technologies, industry decision-making, and public policy. This study will assist SpaceX and other private companies in better understanding their social impact and the wider ramifications for the space industry by examining public opinion.

1.4 OBJECTIVES OF THE STUDY

This study's main goal is to examine how the general public views SpaceX's contributions to space exploration and how those perceptions affect more general opinions about the role of the private sector in the space industry. The study specifically seeks to:

- ✓ Examine how much the general public knows about SpaceX's main projects, such as the Crew Dragon, Starship, and Falcon 9.
- ✓ Compare the public's opinion of SpaceX's missions to that of more established space programs to determine how safe and affordable they are.
- ✓ Find out what the public thinks about the possible technological advances that SpaceX's innovations could lead to.
- ✓ Check the public's support for more private sector involvement in space exploration.
- ✓ Recognize whether the general public believes that space exploration will advance technology and benefit society.

1.5 CHAPTER FRAMEWORK

The chapter framework lists the different chapters that were used in this investigation, giving a concise explanation of the research methodology and how the information acquired aided in the development of significant findings. Different facets of the study are methodically covered in each chapter, ranging from the literature review and background data to the analysis of the results and the development of conclusions.

- **Chapter 1:** The introduction describes the study's goals, significance, and research problem in addition to giving background on SpaceX's involvement in space exploration.

- **Chapter 2:** The literature review looks at previous studies on how the general public views space travel and the effects of private enterprises like SpaceX.

- **Chapter 3:** The research design, methods for gathering data, and analysis strategies employed in the study are described in detail in the theory and methodology section.

- **Chapter 4:** The results section of the report provides detailed insights into the evaluations presented by the enumerated analysis of the data collected.

- **Chapter 5:** The discussion and conclusion highlight the study's main conclusions, wider implications for the space industry, and suggestions for additional research.

CHAPTER 2 – LITERATURE REVIEW

The private sector's role in space exploration has undergone significant change in the last 20 years, with SpaceX at the forefront of it. The impact of the private sector on public expectations and perceptions of space exploration has been the focus of many studies, particularly with regard to SpaceX's advanced technologies. Technological developments, safety, cost reduction, and the broader societal impacts of space related activities are important themes in the literature on this topic.

According to a study by Platt et al. (2020), public awareness of SpaceX and its main projects, including plans for Mars colonization and the development of reusable rockets, has significantly increased as a result of the company's well-publicized accomplishments. According to their research, public perception is significantly shaped by media coverage, despite the fact that little is known about the risks and technical difficulties associated with these missions.

Another important topic covered in the literature is how cost-effective SpaceX's initiatives are. Technology advancements in reusable space systems are highlighted by Baiocco (2021), who shows how developments such as SpaceX's reusable rockets could lower the cost of space exploration. Public opinion is split, though; according to Reddy (2018), some people are hopeful that innovations in the private sector will reduce costs, while others doubt whether these savings will ultimately benefit society.

In conclusion, although there is a growing body of research on how the public views private space exploration, little is known about how SpaceX's particular technologies and missions affect long-term expectations for space travel. This study looks at public awareness, perceptions of safety, cost-effectiveness, and the social impact of SpaceX's innovations in an effort to close that gap.

CHAPTER 3 – THEORY AND METHODOLOGY

This section on theory and methodology describes the procedures used to carry out the study. It describes the methods used to collect the sample data and how the quantity and quality of the data supported the goals of the study. To find out how the public views SpaceX's contributions to space exploration, a structured questionnaire was used, with an emphasis on awareness, safety, cost-effectiveness, and the possible technological impact.

In order to determine central tendencies, variability, and distribution, statistical techniques were applied to the data, which offers a comprehensive picture of public opinion. Analyzing demographic data also helped put the results in context and made sure they appropriately represented the main traits of the population that was surveyed.

3.1 RESEARCH DESIGN

This quantitative research design has allowed this study to take up public opinions about the contribution of SpaceX to the exploration of space in a systematic and objective way. In order to get the data, the descriptive method was used, which could provide an insight into how the general public views certain missions and technological developments at SpaceX. The objectives were focused on public awareness, perceived safety, affordability perceptions, and how technological development at SpaceX would impact future travels in space.

A structured questionnaire was the major tool of data collection, aimed at demographic information and opinions that concern innovations undertaken by SpaceX. These can be used to measure public sentiment, with statistical comparisons across different respondent groups based on perceptions and knowledge of SpaceX. Categories of questions included public awareness of SpaceX's missions: Falcon 9, Starship, and Crew Dragon, perceived safety, cost-effectiveness, and the possibility of additional participation of the private sector in space exploration. Also, a question was asked if they feel that spending money on space technologies could benefit society in a noticeable way.

3.2 DATA COLLECTION METHOD

The information was gathered using a survey from Google Forms, shared by email and social media with 100 respondents. Focusing on people interested in science, technology, and space exploration, the survey assured that the participants had a basic idea about the subject matters. Social networking meant that a large audience could be attained, and snowball sampling was employed through asking users to tell friends to respond to the survey to increase the number of respondents.

3.3 STRUCTURE OF THE QUESTIONNAIRE

The questionnaire developed for the study titled **“Public Perception and Awareness of SpaceX’s Role in Space Exploration and its Impact on Future Technologies”** has been carefully structured to collect valuable data while ensuring ethical standards are maintained.

The first two questions gather demographic data, including the age and gender of the participants. The following three questions assess the participant’s general awareness of SpaceX and its missions. These questions include: **“How familiar are you with SpaceX’s reusable rocket technology?”** and **“Which SpaceX missions have you heard of?”** Additionally, **“How often do you follow news related to space exploration?”** helps gauge the level of engagement with space-related topics.

The following six questions examine further into how the general public views SpaceX and its impact on space technology going forward. Such questions as **"Do you believe that SpaceX's reusable rocket technology is a breakthrough in space travel?"** probe opinions regarding the company's accomplishments. And **"How has SpaceX affected the future of space exploration, in your opinion?", "Do you think that SpaceX's advancements will lead to more private companies entering the space industry?"** is another question.

As well as **"How safe do you think SpaceX missions are in comparison to conventional government space programs?"** This section attempts to gather public opinion regarding SpaceX's impact on the industry as a whole as well as on technology. Additionally, there are direct questions like **"Do you think SpaceX missions are more affordable than those by government space agencies?"** in this section. And **"Are you interested in having more knowledge about space exploration through educational programs?"** These inquiries gauge public interest in SpaceX-related educational initiatives as well as opinions on the price of space exploration.

The primary focus of the last four questions is shifted to the wider technological and societal aspects of SpaceX's advancements. Questions **like "Do you think that investments in space exploration can lead to new technological advancements for everyday use?" and "How likely do you think SpaceX's technologies will improve life on Earth?"** are designed to find out what participants think about the usefulness of space exploration. **"Do you think public-private partnerships are essential for future advancements in space technology?" and "Would you support government funding for companies like SpaceX?"** are the last two questions on the questionnaire. Public opinion on government collaboration and participation in space innovation is examined by these questions.

3.4 PRELIMINARY DATA ANALYSIS

3.4.1 DESCRIPTIVE DATA ANALYSIS

For the study "Public Perception and Awareness of SpaceX's Role in Space Exploration and its Impact on Future Technologies," 100 responses were collected as part of the data collection process. A concise evaluation of the data using descriptive data analysis revealed interesting trends and insights regarding public awareness of SpaceX's missions, perceived safety, cost-effectiveness, and the potential technological impacts of the company's innovations.

1. **Age**

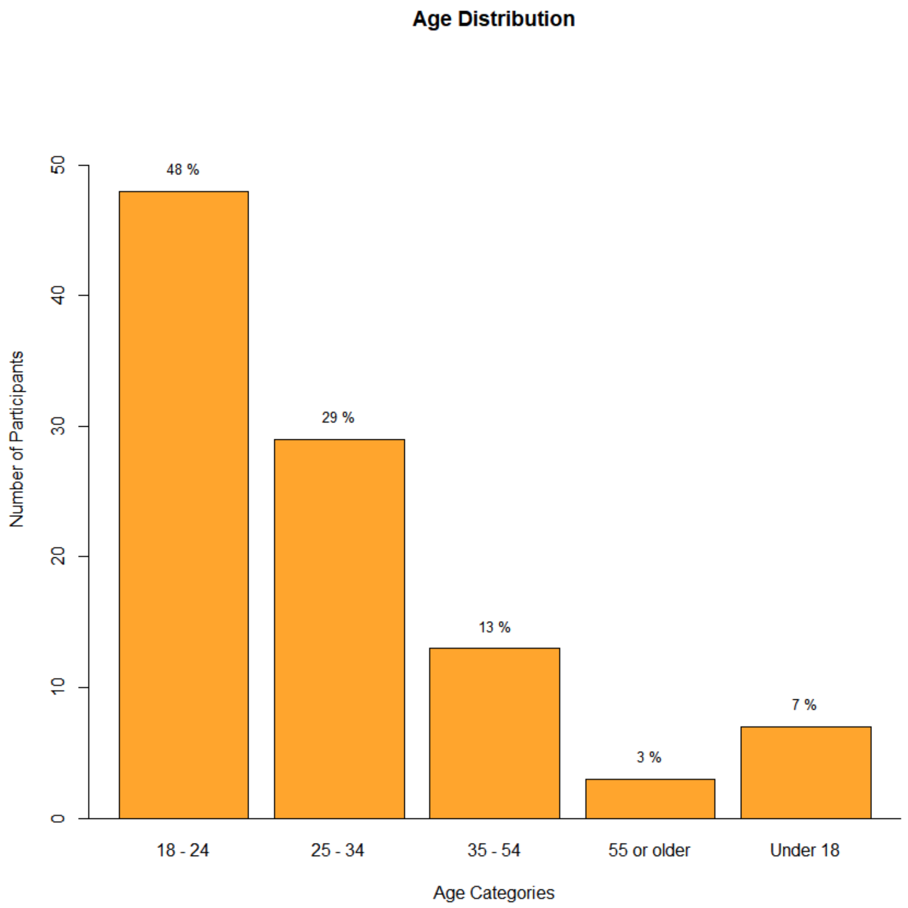

Figure 1: Composition of Age of Respondents

- The 18–24 age group is the most represented demographic in the survey, with 48% of respondents.

- The 25–34 age group, which comes in second with 29%, indicates a significant presence of adults in the early stages of their careers.

- 13% of respondents fall within the 35-54 age group, showing moderate engagement from middle-aged participants.

- The 55 or older category represents only 3% of respondents, suggesting limited participation from older demographics.

- The Under 18 group makes up 7% of respondents, showing some level of engagement from teenagers, though they form a smaller segment of the sample.

2. Familiarity with SpaceX's Reusable Rocket Technology

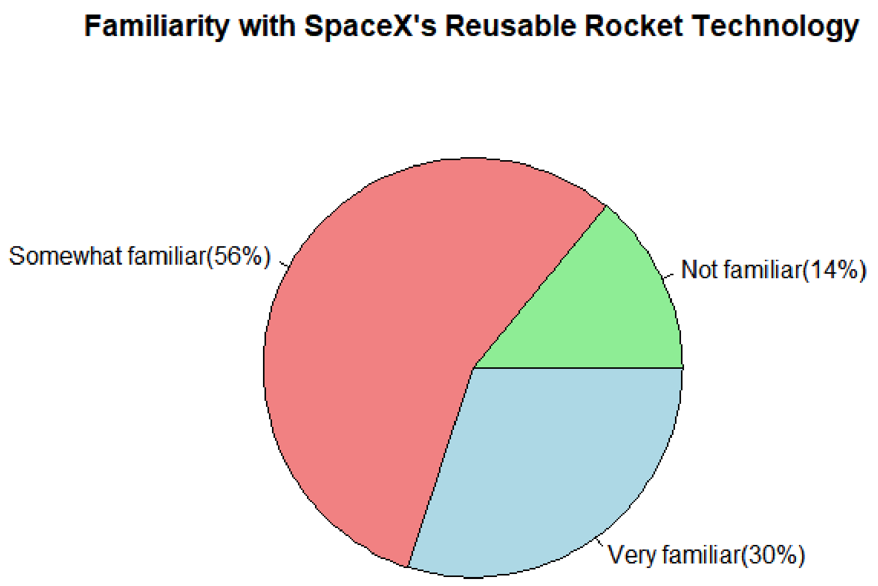

Figure 2: Familiarity with SpaceX's Reusable Rocket Technology

According to the pie chart:

- Despite having limited knowledge, the majority of respondents (56%) are at least somewhat familiar with SpaceX's reusable rocket technology.

- Notably, 30% of those surveyed are highly familiar with SpaceX's innovations, indicating a keen interest in them.

- Only 14% are not familiar, suggesting that most have at least some awareness of SpaceX's contributions.

3.4.2 ANALYZING DEMOGRAPHIC DATA

According to the data gathered:

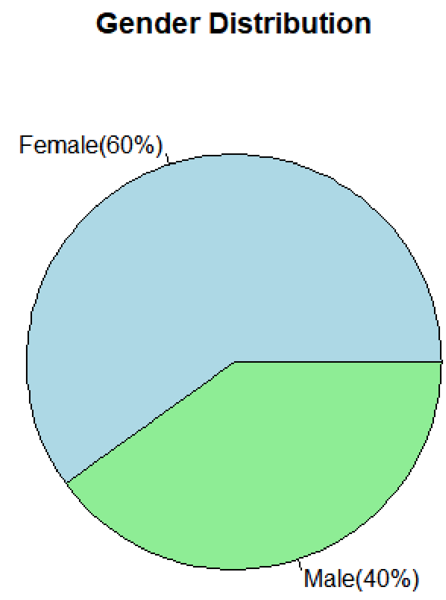

Figure 3: Composition of Gender

According to the pie chart:

- The survey shows a higher participation from females, making up 60% of respondents.
- Males represent a smaller portion, accounting for 40% of the survey participants.
- The distribution is reasonable because there is a slight majority of females, thus allowing multiple perspectives from both genders.

CHAPTER 4 – DESCRIPTIVE DATA ANALYSIS

The data analysis helps characterize public opinion on space exploration and its technological impact by offering precise insights into the sample's perception and awareness of SpaceX. Central tendencies, variation, quartiles, and skewness are some of the metrics that are used to gather data on public perceptions, awareness levels, and the perceived advantages of SpaceX's innovations. Finding response variations is part of this, as it helps identify anomalies. This assessment is further supported by visual representations like frequency curves or box-and-whisker plots (for variation) and bar or pie charts (for distribution). Combining these numerical and visual data allows us to make inferences, test hypotheses, and make correlations about public interest in space exploration education initiatives. To gain a deeper understanding of comparative safety perceptions, we also use a chi-square test to evaluate public opinion regarding the safety of SpaceX missions in comparison to traditional space programs.

AGE OF PARTICIPANTS:

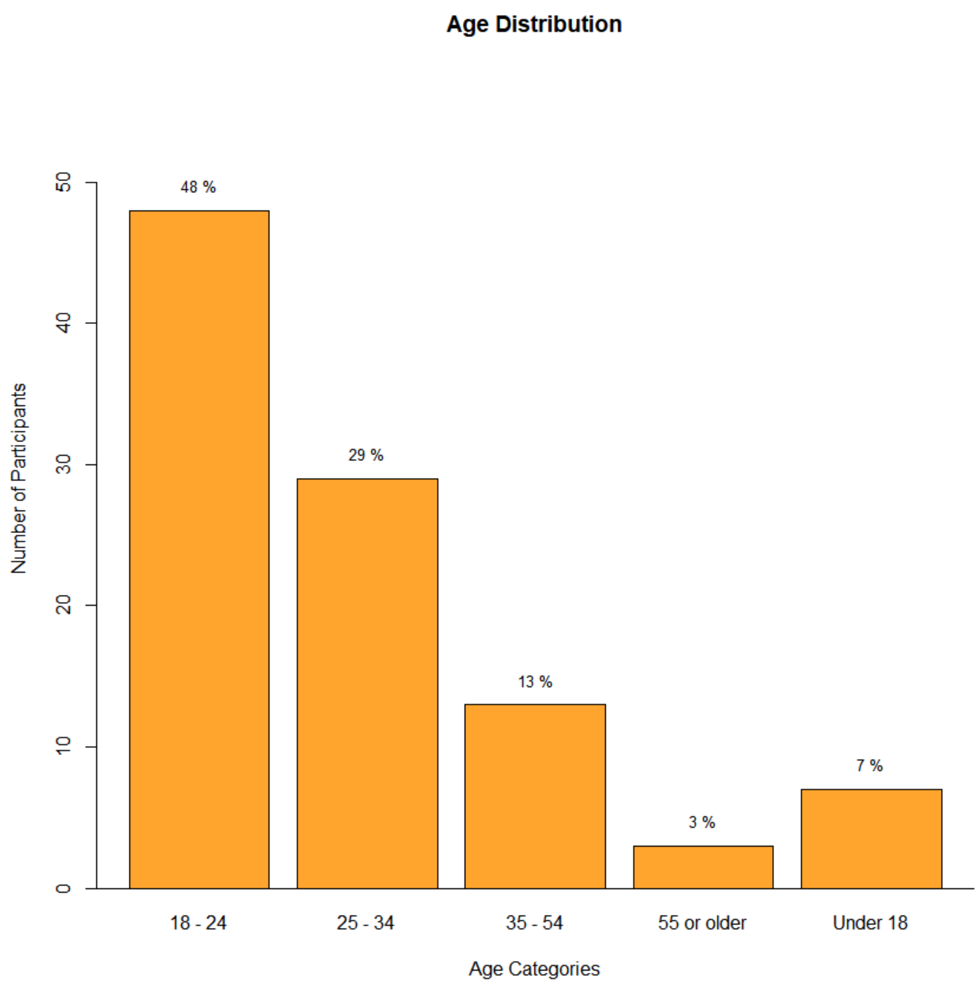

Figure 4: Using RStudio Age of Respondents

Age Categories	Boundaries	Number of Participants (f_i)	Midpoint (x_i)	$f_i x_i$	$(x_i - \bar{X})^2$
Under 18	0 – 17.5	7	8.5	59.5	354.4
18-24	17.5 – 24.5	48	21	1008	40
25-34	24.5 – 34.5	29	29.5	855.5	4.7
35-54	34.5 – 54.5	13	44.5	578.5	295
55 or older	54.5 – 99.5	3	77	231	2467.6
		Total = 100		**Total = 2732.5**	**Total = 3161.7**

Table 1: Composition of Age

- **Sample Mean($\bar{X}$) = $\frac{\Sigma f_i x_i}{\Sigma f_i}$**
  - ✓ Sample Mean($\bar{X}$) = $\frac{2732.5}{100}$ = 27.325

```
> # Define the midpoints and frequencies
> midpoints <- c(8.5, 21, 29.5, 44.5, 77)
> frequencies <- c(7, 48, 29, 13, 3)
> # Calculate the mean
> mean_age <- sum(midpoints * frequencies) / sum(frequencies)
> # Calculate the variance
> variance_age <- sum((midpoints - mean_age)^2) / (sum(frequencies)-1)
> # Calculate the standard deviation
> sd_age <- sqrt(variance_age)
> # Print results
> mean_age
[1] 27.325
> variance_age
[1] 31.9364
> sd_age
[1] 5.65123
```

Figure 5: RStudio Code for Mean, Variance, Standard Deviation

- **Sample Variance (S^2) = $\frac{\sum(x_i-\bar{X})^2}{n-1}$**

  - ✓ Sample Variance (S^2) = 31.9364

- **Sample Standard Deviation (S) = $\sqrt{S^2}$**

  - ✓ Sample Standard Deviation (S) = 5.65123

- **Determining Median and Mode Age Category**

Age Category	Frequency	Cumulative Frequency
Under 18	7	7
18 – 24	48	55
25 – 34	29	84
35 – 54	13	97
55 or older	3	100

Table 2: Determining Median and Mode Age Category

- Determining Median Age Category

  - ✓ Identify the median position: $\frac{100}{2}$ = 50

  - ✓ Conclude that 50^{th} participant falls in the 18-24 age category which has the cumulative frequency of 55.

  - ✓ **Sample Median Age Category = 18-24**

- Determining Mode Age Category
  - ✓ The 18-24 age category has the highest frequency, with 48 participants.
  - ✓ **Sample Mode Age Category = 18-24**

The findings of this study indicate that the majority of people who are aware of SpaceX's contributions to space exploration are in the 18–24 age range, which also happens to be the dataset's mode. The median age is in the same range as the mean age of the respondents, which is 27.325. 31.94 is the variance, and 5.65 is the standard deviation. According to these estimates, the majority of users active in discussions regarding SpaceX and its implications for future technologies are between the ages of 18 and 24.

GENDER OF PARTICIPANTS:

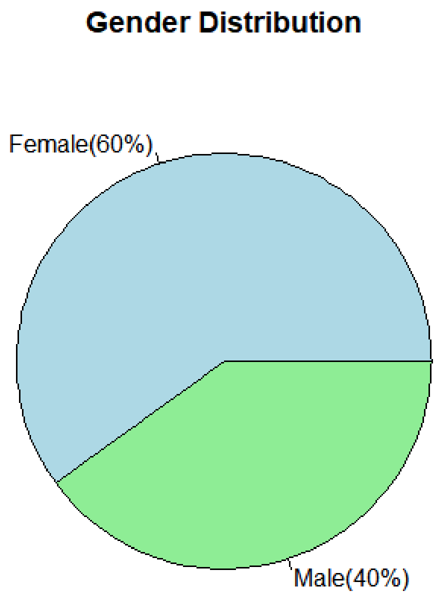

Figure 6: Using RStudio - Distribution of gender of participants

According to the pie chart above, which was created with RStudio using survey data, 60% of respondents are women and 40% are men. The demographic makeup of the respondents is revealed by this distribution, which shows that women make up the majority of survey respondents who identified their gender.

- **Treemap of Gender Distribution from Survey Data**

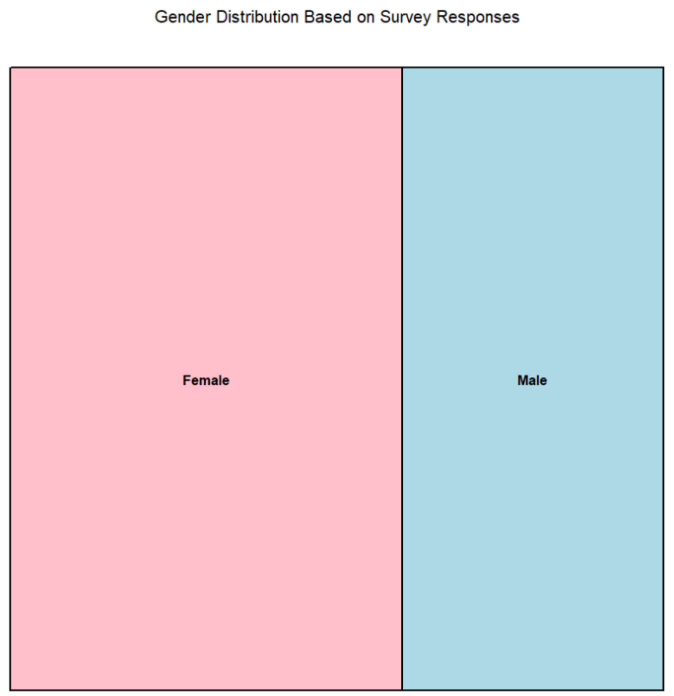

Figure 7: Using RStudio - Treemap of Gender Distribution from Survey Data

Familiarity with SpaceX's Reusable Rocket Technology

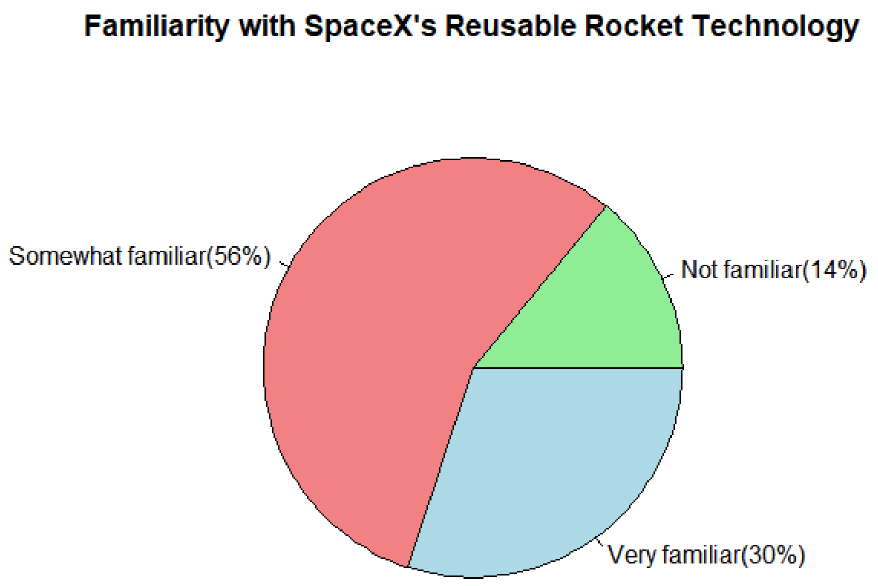

Figure 8: Using RStudio for Familiarity with SpaceX's Reusable Rocket Technology

Statistic	Value
Mean	2.16
Median	2
Variance	0.41
Standard Deviation	0.64

Table 3: Statistics Using RStudio for Familiarity with Reusable Rocket Technology

- ✓ According to the survey results, the most common response was "Somewhat familiar," with 56% of respondents saying they were aware of SpaceX's reusable rocket technology. Thirty percent are also "Very familiar," and fourteen percent are "Not familiar." In general, respondents tend to be "Somewhat familiar," as indicated by the mean familiarity level of 2.16 and median of 2.

- ✓ With a standard deviation of 0.6437 and variance of 0.4144, the data indicates low variability and consistent participant familiarity levels. With only a small portion of respondents still being unfamiliar, these findings show that respondents generally have a moderate to high awareness of SpaceX's reusable rocket technology.

Statistical Calculations for Familiarity with SpaceX's Reusable Rocket Technology Using RStudio

```r
# Familiarity with SpaceX's Reusable Rocket Technology

responses <- c(1, 2, 3)  # Numerical values for each category: Not familiar (1), Somewhat familiar (2), Very f
percentages <- c(14, 56, 30)  # Percentage of respondents for each category

counts <- percentages * 100 / 100

mean_value <- sum(responses * counts) / sum(counts)


all_responses <- rep(responses, times = counts)
median_value <- median(all_responses)

variance_value <- sum((responses - mean_value)^2 * counts) / sum(counts)

std_dev_value <- sqrt(variance_value)
mean_value
median_value
variance_value
std_dev_value
```

175:14 (Top Level) ÷ R Script

Console Terminal Background Jobs

R 4.4.1 · D:/1.UOB/PS ASSIGNMENT/

```r
> counts <- percentages * 100 / 100
>
> mean_value <- sum(responses * counts) / sum(counts)
>
>
> all_responses <- rep(responses, times = counts)
> median_value <- median(all_responses)
>
> variance_value <- sum((responses - mean_value)^2 * counts) / sum(counts)
>
> std_dev_value <- sqrt(variance_value)
> mean_value
[1] 2.16
> median_value
[1] 2
> variance_value
[1] 0.4144
> std_dev_value
[1] 0.6437391
```

Figure 9: Calculations for Familiarity with SpaceX's Reusable Rocket Technology

Awareness of SpaceX Missions among Respondents

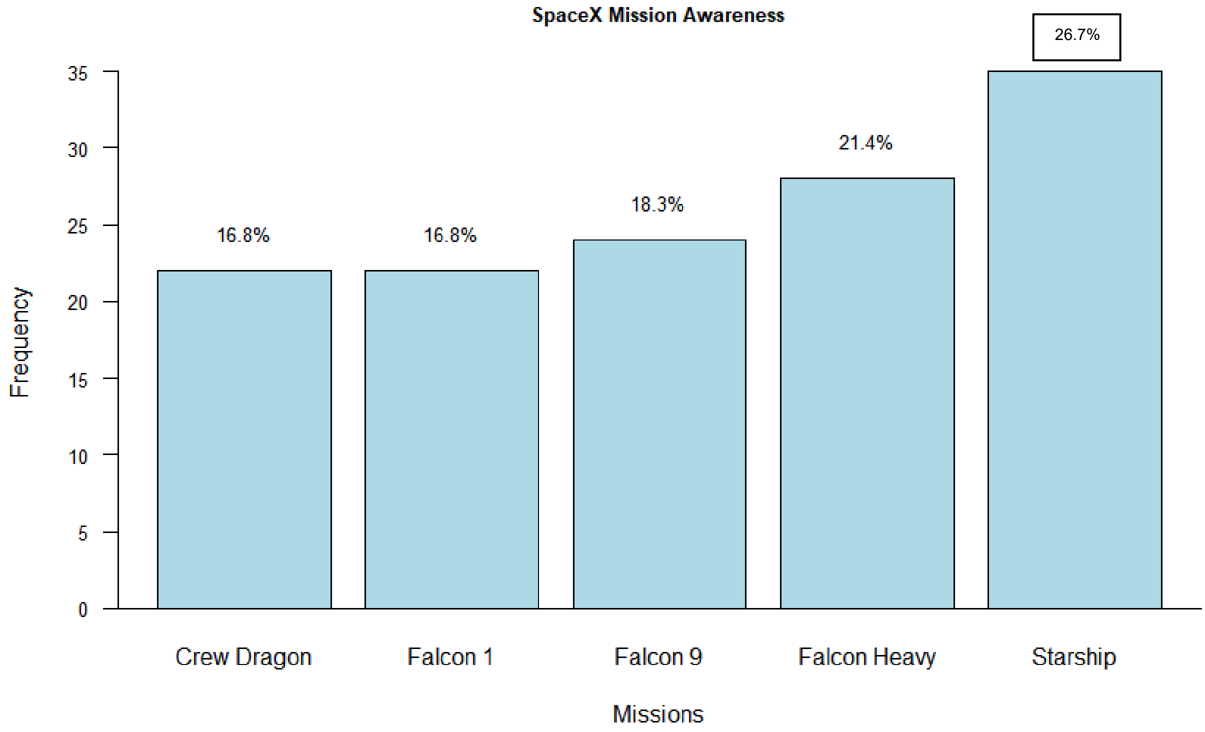

Figure 10: Using RStudio to Project the Awareness of SpaceX Missions

The above vertical bar chart shows how respondents are aware of the different SpaceX missions. Insights into the public's familiarity with SpaceX's mission range were obtained by allowing participants to choose from a variety of missions. Out of all the missions, the Starship mission is the most well-known, with 26.7% of participants indicating that they are aware of it. Of those surveyed, 18.3% are familiar with Falcon 9, and 21.4% are familiar with Falcon Heavy after Starship. Equal numbers of participants (16.8%) are familiar with Crew Dragon and Falcon 1 respectively.

Public Interest in Space Exploration Educational Programs

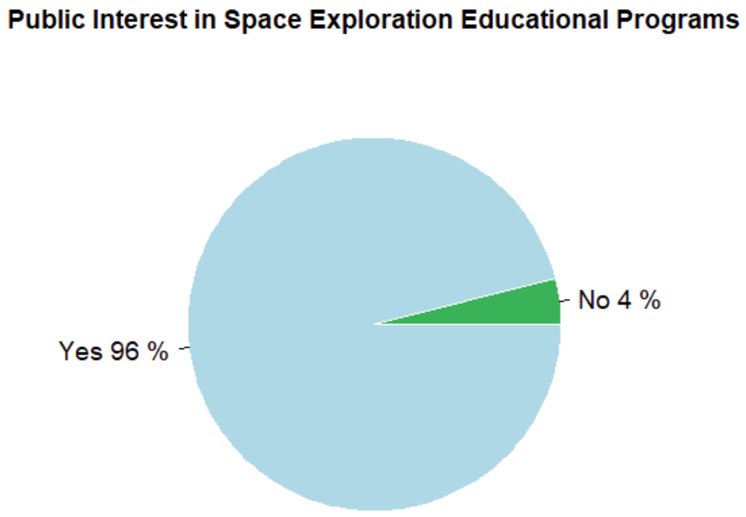

Figure 11: Using RStudio to Project the Public Interest in Space Educational Programs

- ✓ **Hypothesis Testing Objective:** To determine if public interest in space exploration educational programs is greater than 90%.

  Note: A significance level of 5% (alpha = 0.05) was chosen for this hypothesis test. This level is commonly used when the population standard deviation is unknown and when balancing sensitivity and caution in decision-making. Given our sample data, a 5% significance level provides an appropriate threshold for evaluating whether public interest in space exploration educational programs exceeds 90%.

  - **Step 1: Define the Hypotheses (H0 and H1)**

- ✓ **H0 (Null Hypothesis)**: The true proportion of people interested in space exploration educational programs is 90% or less.
- ✓ **H1 (Alternative Hypothesis)**: The true proportion of people interested is greater than 90%.

- **Step 2: Gather Data and Calculate Sample Statistics**
  - ✓ Total respondents (n) = 100
  - ✓ Number of “Yes” responses = 96
  - ✓ Sample proportion ($\hat{p}$) = $\frac{96}{100}$ = 0.96
  - ✓ Number of “No” responses = 4

- **Step 3: Calculate Sample Mean and Standard Deviation**
  - ✓ The sample mean percentage of interest is 96%
  - ✓ Sample Standard Deviation for Proportion:
    - The standard deviation of sample proportion can be calculated using the formula:
      - ➢ $\sigma_{\hat{p}} = \sqrt{\frac{p_0(1-p_0)}{n}}$
      - ➢ Where $p_0 = 0.90$ (Hypothesized population proportion)
  - ✓ $\sigma_{\hat{p}} = \sqrt{\frac{0.90(1-0.90)}{100}} = \sqrt{\frac{0.90(0.10)}{100}} = \sqrt{0.0009}$ = 0.03

- **Step 4: Calculate the Test Statistics**
  - ✓ The test statistics (Z) can be calculated using the formula:
  - ✓ $z = \frac{\hat{p}-p_0}{\sigma_{\hat{p}}}$
    - $z = \frac{0.96-0.90}{0.03} = \frac{0.06}{0.03} = 2$

- **Step 5: Determine the Critical Value**

  ✓ Since this is a one-tailed test with a significance level of 5% (0.05), the critical z-value from the z-table for a one-tailed test at the 0.05 level is approximately 1.645.

- **Step 6: Make a Decision**

  ✓ Test Statistics Z = 2

  ✓ Critical Z-Value ≈ 1.645

Since Z (2) is greater than the critical value (1.645), that is (2 > 1.645), we reject the null hypothesis (H0).

- **Step 7: Conclusion**

  ✓ Based on the test, we do not have sufficient evidence at the 5% significance level to conclude that the true proportion of people interested in space exploration educational programs is greater than 90%.

```r
# Given values
n <- 100
x <- 96
p_hat <- x / n
p0 <- 0.90
alpha <- 0.05
# Step 3: Calculate the standard deviation of the sample proportion
std_dev <- sqrt(p0 * (1 - p0) / n)
# Step 4: Calculate the test statistic (Z)
z <- (p_hat - p0) / std_dev
# Step 5: Critical Z-value for one-tailed test at 5% significance level
z_critical <- qnorm(1 - alpha)
# Step 6: Decision
if (z > z_critical) {
  decision <- "Reject the null hypothesis"
} else {
  decision <- "Fail to reject the null hypothesis"
}
# Display the results
cat("Sample Proportion (p̂):", p_hat, "\n")
cat("Hypothesized Proportion (p0):", p0, "\n")
cat("Standard Deviation:", std_dev, "\n")
cat("Test Statistic (Z):", z, "\n")
cat("Critical Z-Value:", z_critical, "\n")
cat("Decision:", decision, "\n")
```

279:33 (Top Level)

Console Terminal Background Jobs

R 4.4.1 · D:/1.UOB/PS ASSIGNNMENT/

```
> # Step 6: Decision
> if (z > z_critical) {
+   decision <- "Reject the null hypothesis"
+ } else {
+   decision <- "Fail to reject the null hypothesis"
+ }
> # Display the results
> cat("Sample Proportion (p̂):", p_hat, "\n")
Sample Proportion (p̂): 0.96
> cat("Hypothesized Proportion (p0):", p0, "\n")
Hypothesized Proportion (p0): 0.9
> cat("Standard Deviation:", std_dev, "\n")
Standard Deviation: 0.03
> cat("Test Statistic (Z):", z, "\n")
Test Statistic (Z): 2
> cat("Critical Z-Value:", z_critical, "\n")
Critical Z-Value: 1.644854
> cat("Decision:", decision, "\n")
Decision: Reject the null hypothesis
```

Figure 12: Using RStudio for the Hypothesis Testing

Perception of SpaceX Safety Compared to Government Programs by Age Groups

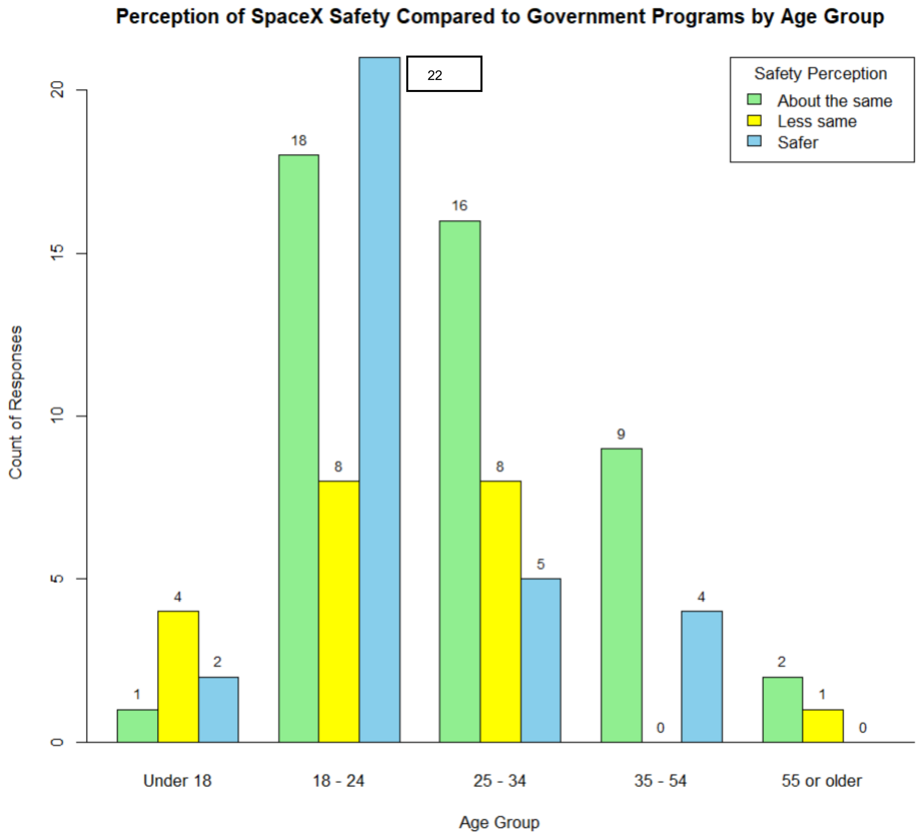

Figure 13: Using RStudio to visualize the Perception of SpaceX Safety by Age Groups

❖ Chi-Square Test for Independence

The bar chart above illustrates survey responses to two questions: “What is your age?” and “How safe do you think SpaceX missions are in comparison to conventional government space programs?” Age groups are represented by the x-axis in this case, and the number of responses in each category is displayed on the y-axis. Different age-group perceptions of SpaceX's safety are represented by each color coded bars. Respondents who believe SpaceX's safety is "About the same" as government programs are indicated by light green bars.Respondents who believe that SpaceX is "Less Same" than government programs are indicated by yellow bars.Respondents who believe SpaceX's safety is "Safer" than government initiatives are represented by skyblue bars.

- ✓ To determine if there is a relationship between age group and safety perception, we conducted a chi-square test for independence with a 5% significance level (alpha = 0.05).

- ✓ **Contingency Table for Chi-Square Test**

Age Group	**About the same**		**Less Same**		**Safer**		**Total**
Under 18	1	3.22	4	1.47	2	2.31	7
18 - 24	18	22.08	8	10.08	22	15.84	48
25 - 34	16	13.34	8	6.09	5	9.57	29
35 - 54	9	5.98	0	2.73	4	4.29	13
55 or older	2	1.38	1	0.63	0	0.99	3
	46		21		33		100

Table 4: Contingency Table for Chi-Square Test

The above table displays the observed values for the chi-square test in light teal cells. To calculate the chi-square test statistic, we first need to derive the expected values for each cell. These expected values are shown in light sage green cells. By comparing observed and expected frequencies, we can determine whether there is a significant association between the two categorical variables. Each expected value is calculated using the formula:

- ✓ $\boldsymbol{E(x) = \frac{f(c) \times f(r)}{n}}$

- f(c) – total frequency of the specified column
- f(r) – total frequency of the specified row
- n- sample size
- To perform the chi-squared test of independence,

❖ **Step 1: Define the Hypotheses (H0 and H1)**

- ✓ **Null Hypothesis (H0):** There is no association between age group and perception of SpaceX safety.

- ✓ **Alternative Hypothesis (H1):** There is an association between age group and perception of SpaceX safety.

❖ **Step 2: Degrees of Freedom**

- ✓ The degrees of freedom = (Nr−1) (Nc−1) where $\boldsymbol{Nr = no.of\ rows\ and\ Nc = no.of\ columns}$
- ✓ With 5 age groups and 3 perception categories, the degrees of freedom (df) is,

df = (5 - 1) × (3 - 1) = 8

❖ **Step 3:The Decision Rule**

- ✓ Reject $\boldsymbol{H0}$ if the test-statistic value is greater than the critical value found for the corresponding significance value and the degrees of freedom.

- **Step 4: Chi-square Test Statistic:**

  - ✓ The chi-square test statistics was calculated using the equation:
  - ✓ $X^2 = \sum \frac{(O_i - E_i)^2}{E_i}$
  - ✓ Where O_i is the observed frequency and E_i is the expected frequency for each cell.

$$X^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

$$= 18.58$$

  - ✓ P-value = 0.01729

```
> print(contingency_table)

              About the same Less same Safer
  18 - 24                 18         8    22
  25 - 34                 16         8     5
  35 - 54                  9         0     4
  55 or older              2         1     0
  Under 18                 1         4     2
> chi_square_test <- chisq.test(contingency_table)
Warning message:
In chisq.test(contingency_table) :
  Chi-squared approximation may be incorrect
>
> print(chi_square_test)

	Pearson's Chi-squared test

data:  contingency_table
X-squared = 18.578, df = 8, p-value = 0.01729
```

Figure 14: Using RStudio for Chi-Square Test for Independence

Note: With eight degrees of freedom and a 0.05 significance level, the table's corresponding chi-square critical value is 15.507. Based on the observed and expected frequencies, the test statistic comes out to be 18.58. Since the calculated test statistic (18.58) is greater than the critical value (15.507), we reject the null hypothesis.

- **Step 5: Conclusion**

  - ✓ There is sufficient evidence, at the level of significance of 5%, to conclude that there is a significant relationship between the age group and perception of the safety of SpaceX compared to government programs. That is, based on their age groups, people have significantly different perceptions about the safety of SpaceX as compared to traditional government space programs.

- **Scatter Plot of Age vs. Perception of SpaceX's Mission Safety**

Figure 15: Scatter Plot of Age vs. Perception of SpaceX's Mission Safety

CHAPTER 5 – DISCUSSIONS AND CONCLUSION

This study used a survey of 100 participants of different ages to investigate how the public views and understands SpaceX's contribution to space exploration. Respondents between the ages of 18 and 24 made up the largest demographic (48%), with other age groups being moderately represented. The sample was 60% female, demonstrating high participation and a growing interest in space-related subjects. The majority of participants indicated that they were generally familiar with SpaceX's innovations, as evidenced by their awareness of the company's reusable rocket technology. Age was found to be significantly correlated with opinions about SpaceX's safety in comparison to government programs using a chi-square test, suggesting that opinions on safety differ among demographic groups.

Further analysis, including a z-test, showed strong public support for educational initiatives in space exploration, with over 90% of respondents expressing interest. These findings suggest broad awareness and positive perceptions of SpaceX’s technological impact, particularly regarding safety and educational outreach.

In conclusion, there is a generally positive public awareness and perception of SpaceX's contributions to space exploration. Significant participation is found in the study, particularly among women and younger participants, indicating a desire to comprehend space technology advancements. Future field outreach and education initiatives can benefit from these insights.

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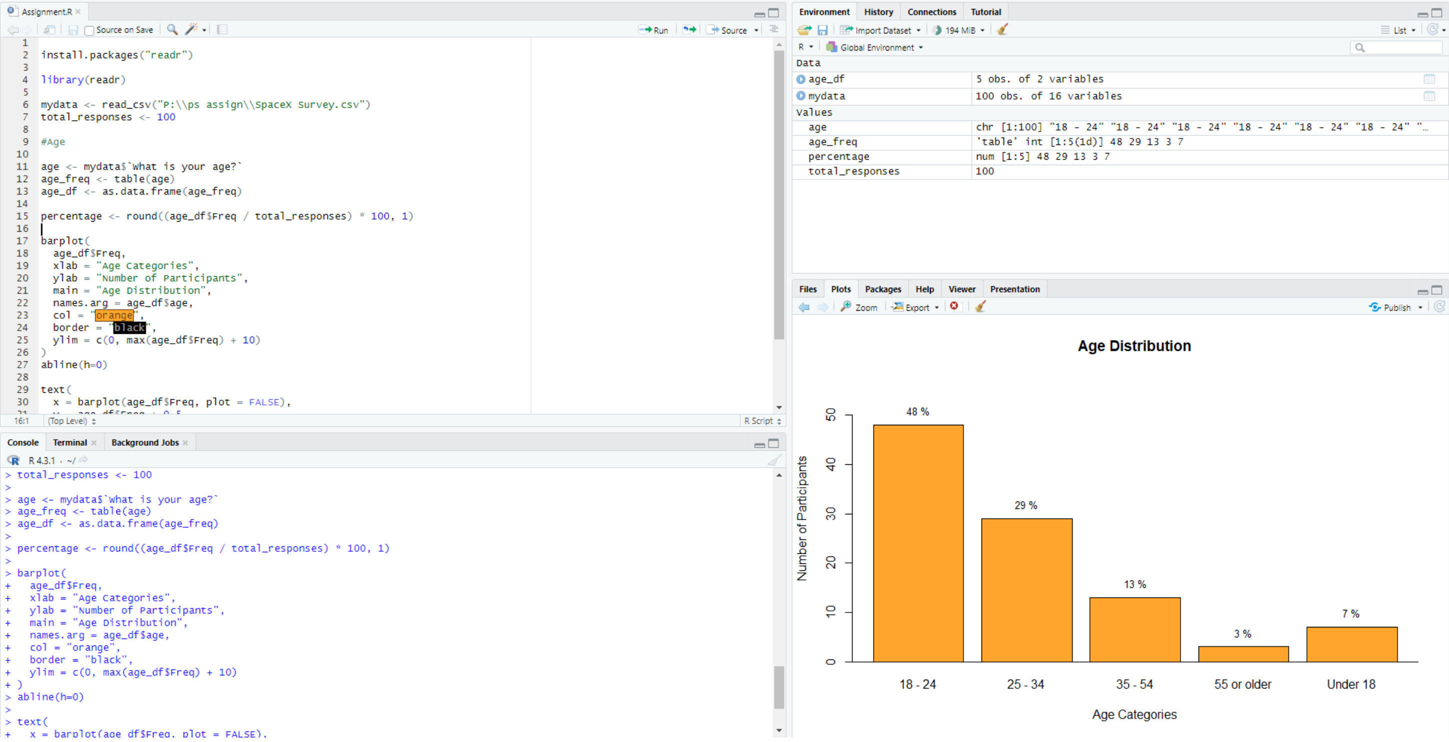
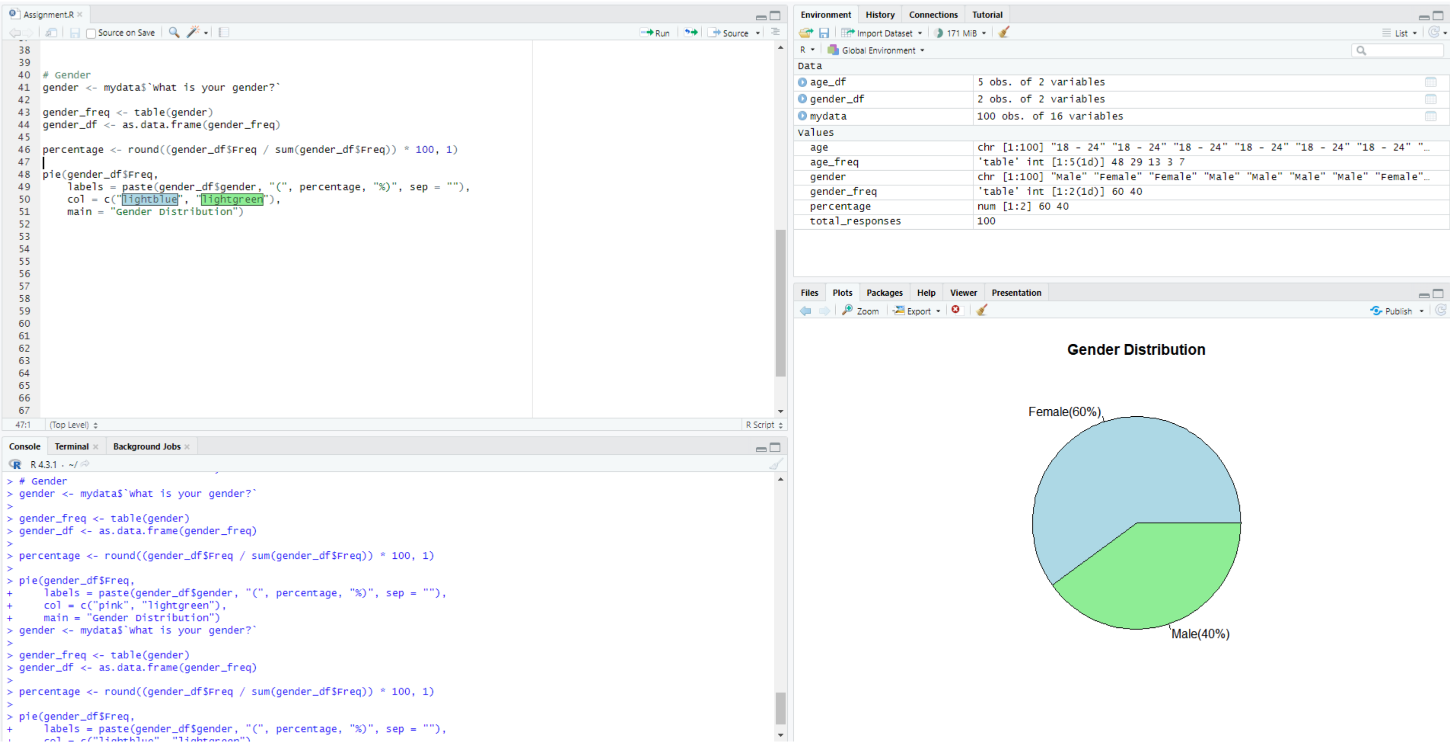
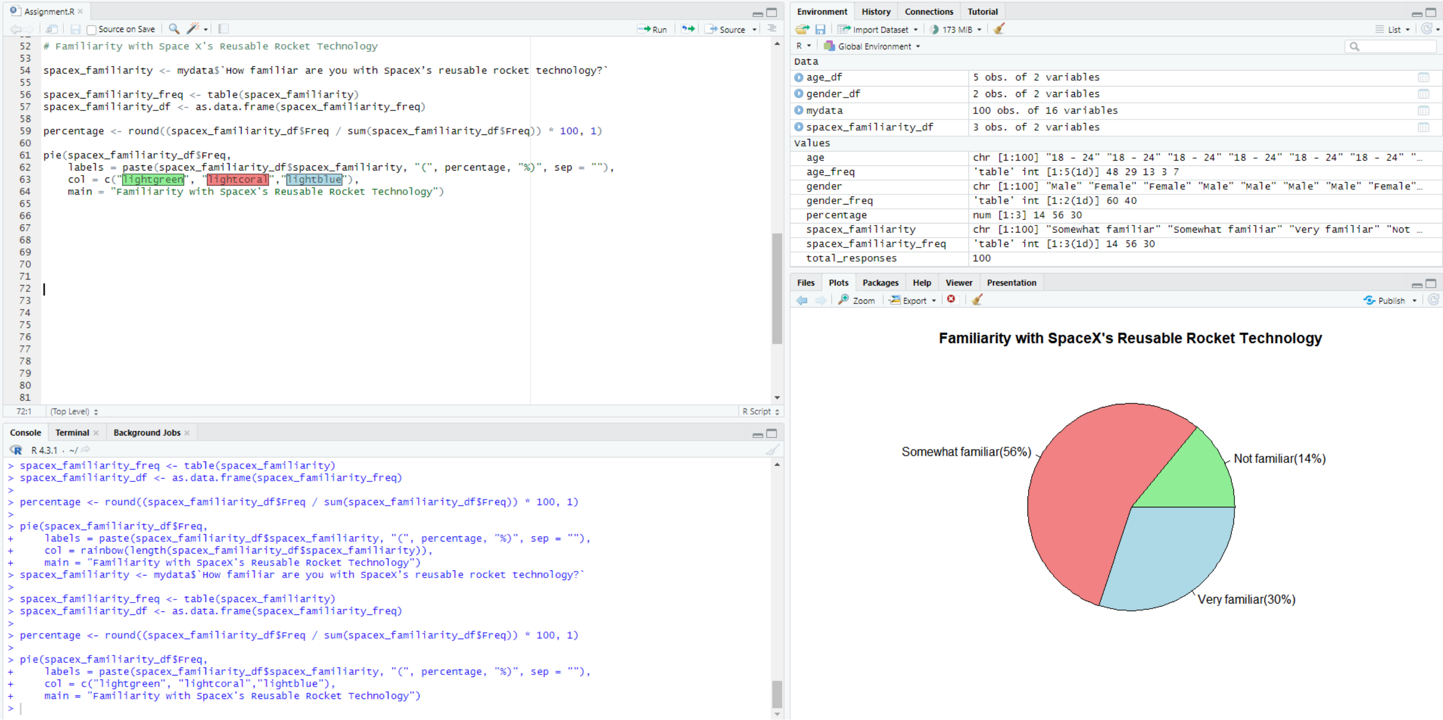
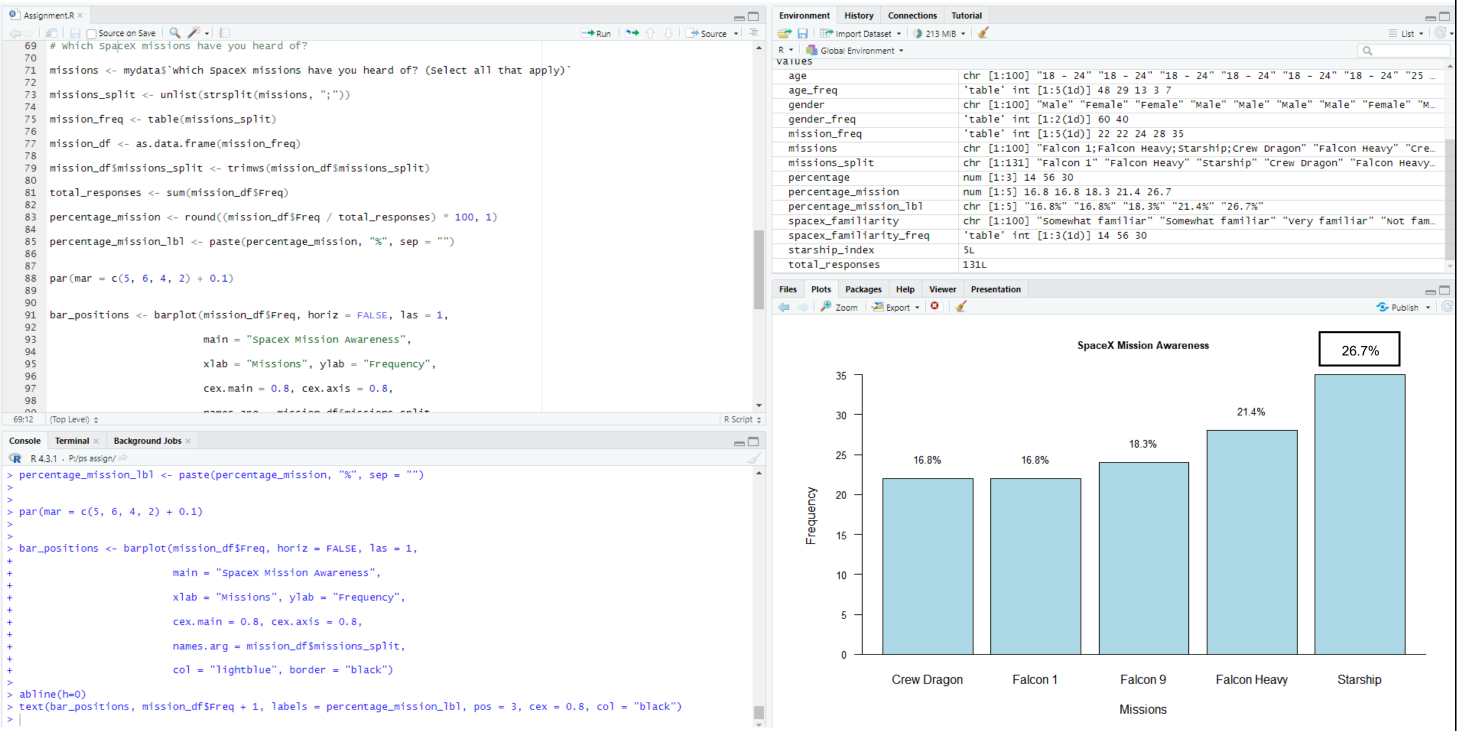
RSTUDIO CODES FOR THE ABOVE ANALYSIS



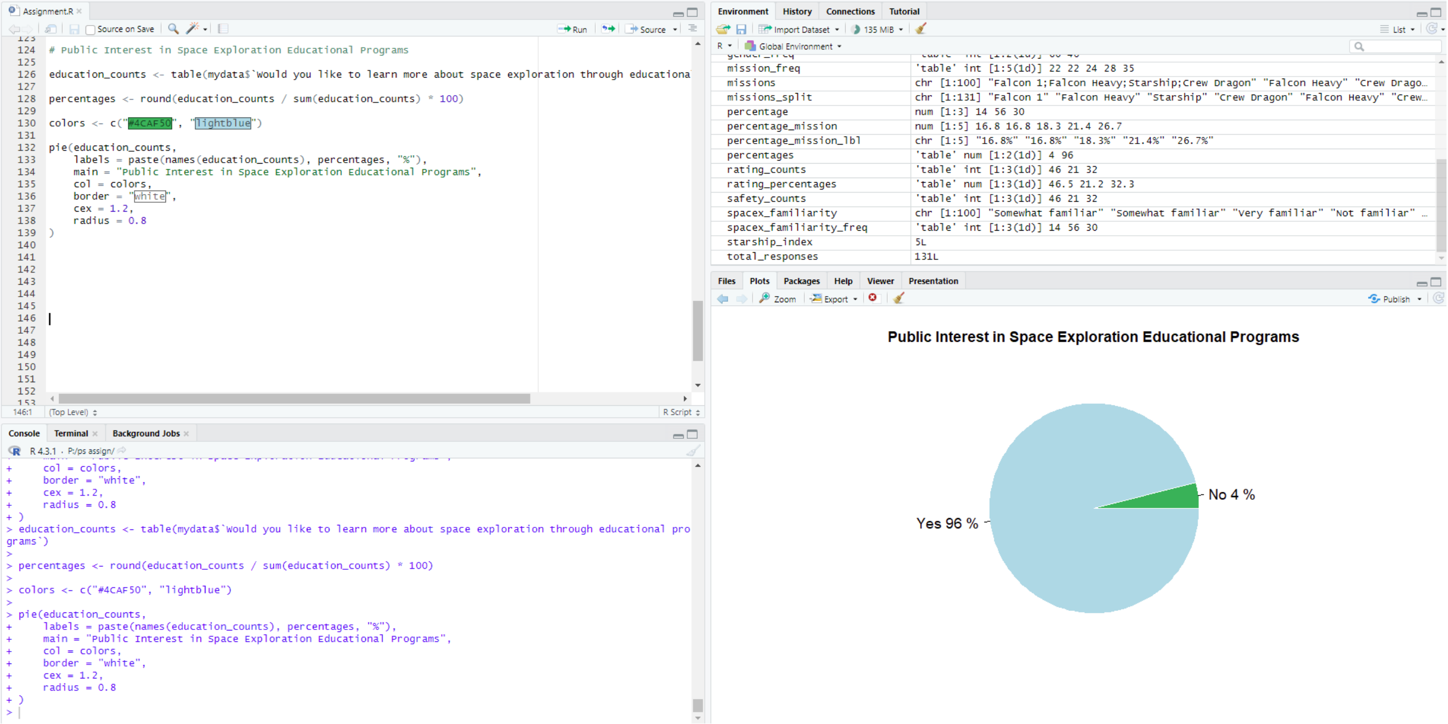




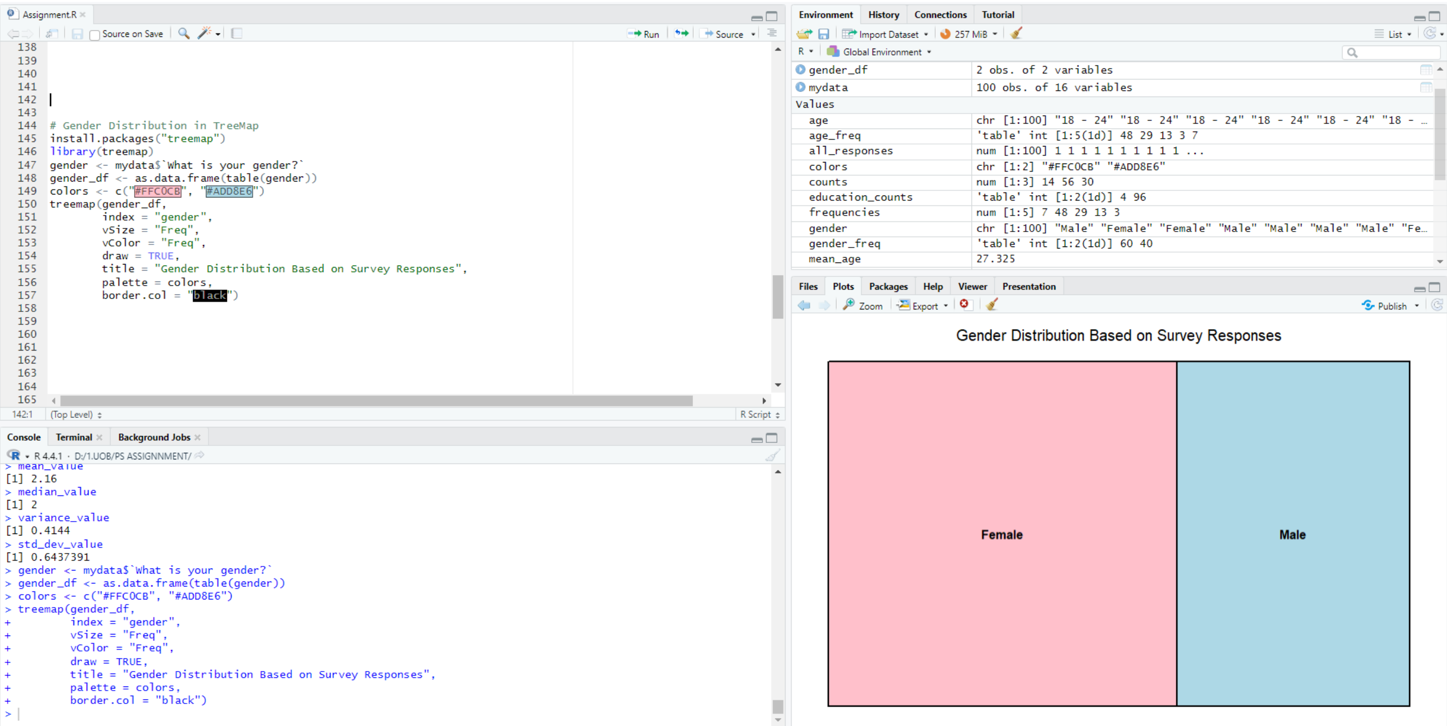
# Familiarity with Space X's Reusable Rocket Technology
spacex_familiarity <- mydata$`How familiar are you with SpaceX's reusable rocket technology?`
spacex_familiarity_freq <- table(spacex_familiarity)
spacex_familiarity_df <- as.data.frame(spacex_familiarity_freq)
percentage <- round((spacex_familiarity_df$Freq / sum(spacex_familiarity_df$Freq)) * 100, 1)
pie(spacex_familiarity_df$Freq,
labels = paste(spacex_familiarity_df$spacex_familiarity, "(", percentage, "%)", sep = ""),
col = c("lightgreen", "lightcoral","lightblue"),
main = "Familiarity with SpaceX's Reusable Rocket Technology")
age_df 5 obs. of 2 variables
gender_df 2 obs. of 2 variables
mydata 100 obs. of 16 variables
spacex_familiarity_df 3 obs. of 2 variables
age_freq 'table' int [1:5(1d)] 48 29 13 3 7
gender_freq 'table' int [1:2(1d)] 60 40
percentage num [1:3] 14 56 30
spacex_familiarity_freq 'table' int [1:3(1d)] 14 56 30
total_responses 100
Familiarity with SpaceX's Reusable Rocket Technology
Somewhat familiar(56%)
Not familiar(14%)
Very familiar(30%)



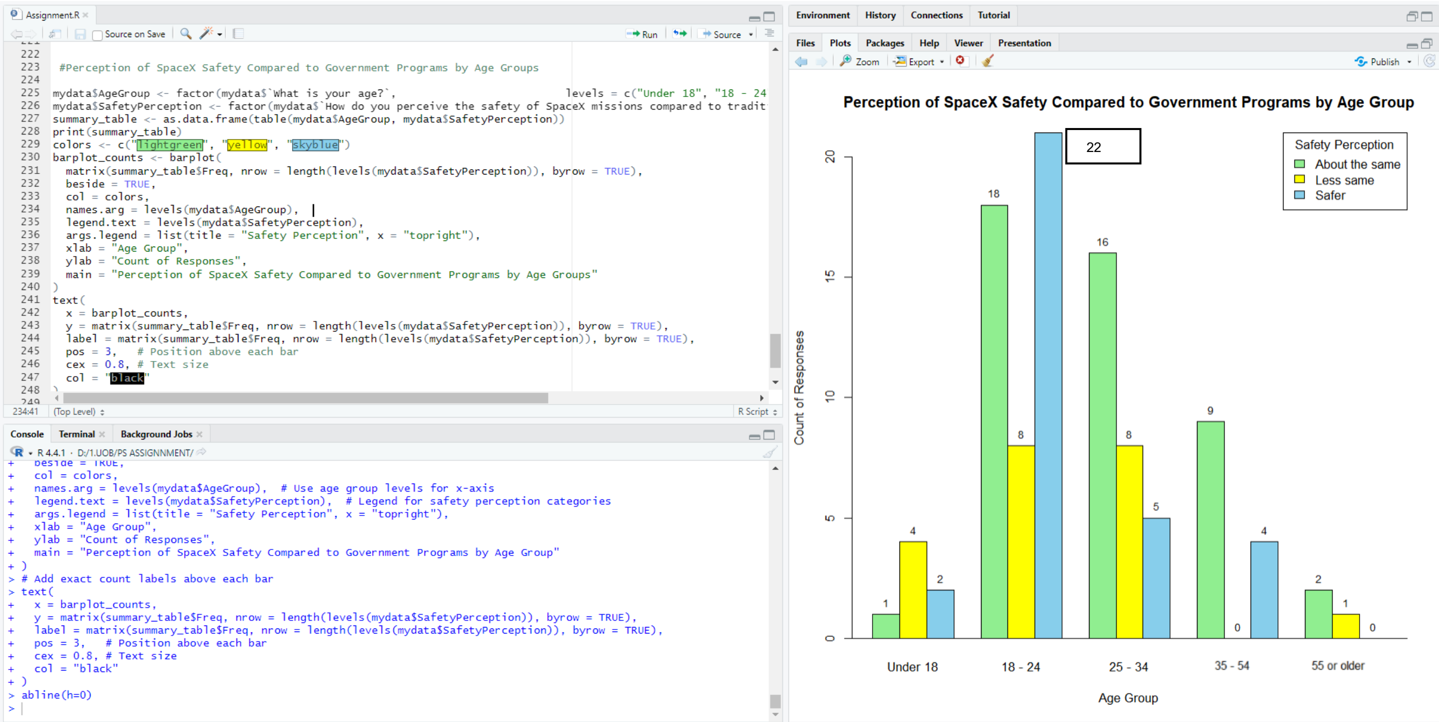
# Which SpaceX missions have you heard of?
missions <- mydata$`Which SpaceX missions have you heard of? (Select all that apply)`
missions_split <- unlist(strsplit(missions, ";"))
mission_freq <- table(missions_split)
mission_df <- as.data.frame(mission_freq)
mission_df$missions_split <- trimws(mission_df$missions_split)
total_responses <- sum(mission_df$Freq)
percentage_mission <- round((mission_df$Freq / total_responses) * 100, 1)
percentage_mission_lbl <- paste(percentage_mission, "%", sep = "")
par(mar = c(5, 6, 4, 2) + 0.1)
bar_positions <- barplot(mission_df$Freq, horiz = FALSE, las = 1,
main = "SpaceX Mission Awareness",
xlab = "Missions", ylab = "Frequency",
cex.main = 0.8, cex.axis = 0.8,
names.arg = mission_df$missions_split,
col = "lightblue", border = "black")
abline(h=0)
text(bar_positions, mission_df$Freq + 1, labels = percentage_mission_lbl, pos = 3, cex = 0.8, col = "black")
mission_freq 'table' int [1:5(1d)] 22 22 24 28 35
percentage_mission num [1:5] 16.8 16.8 18.3 21.4 26.7
starship_index 5L
total_responses 131L
SpaceX Mission Awareness
16.8%
16.8%
18.3%
21.4%
26.7%
Frequency
Crew Dragon
Falcon 1
Falcon 9
Falcon Heavy
Starship
Missions

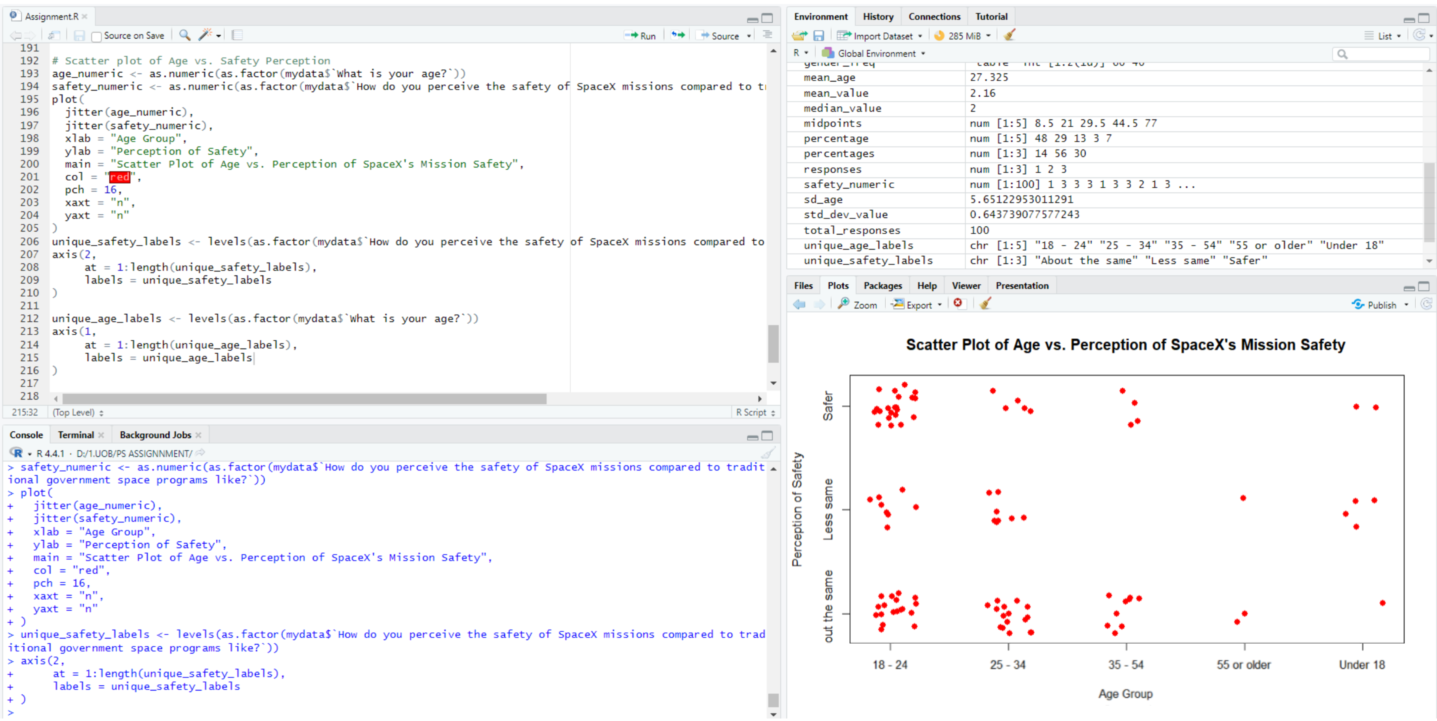


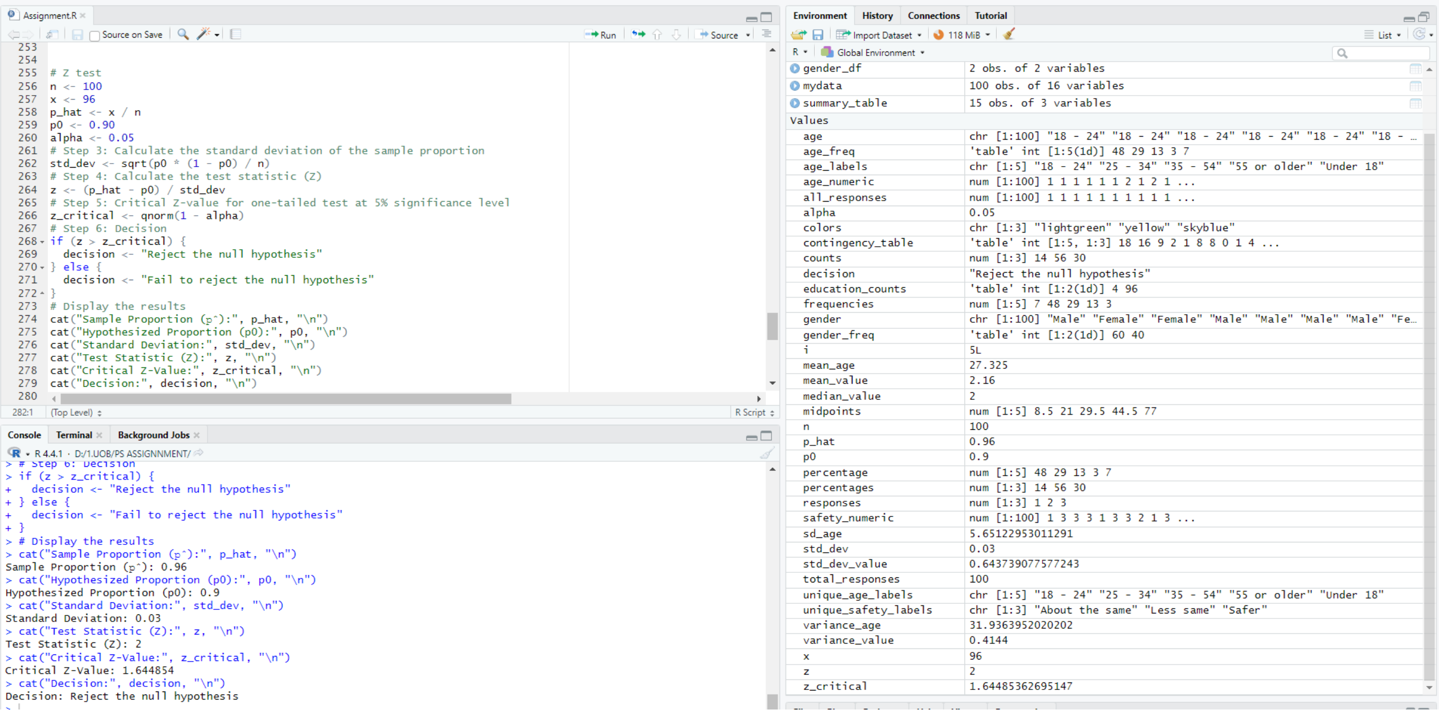
# Public Interest in Space Exploration Educational Programs
education_counts <- table(mydata$`Would you like to learn more about space exploration through educationa
percentages <- round(education_counts / sum(education_counts) * 100)
colors <- c("#4CAF50", "lightblue")
pie(education_counts,
labels = paste(names(education_counts), percentages, "%"),
main = "Public Interest in Space Exploration Educational Programs",
col = colors,
border = "white",
cex = 1.2,
radius = 0.8
)
Public Interest in Space Exploration Educational Programs
No 4 %
Yes 96 %

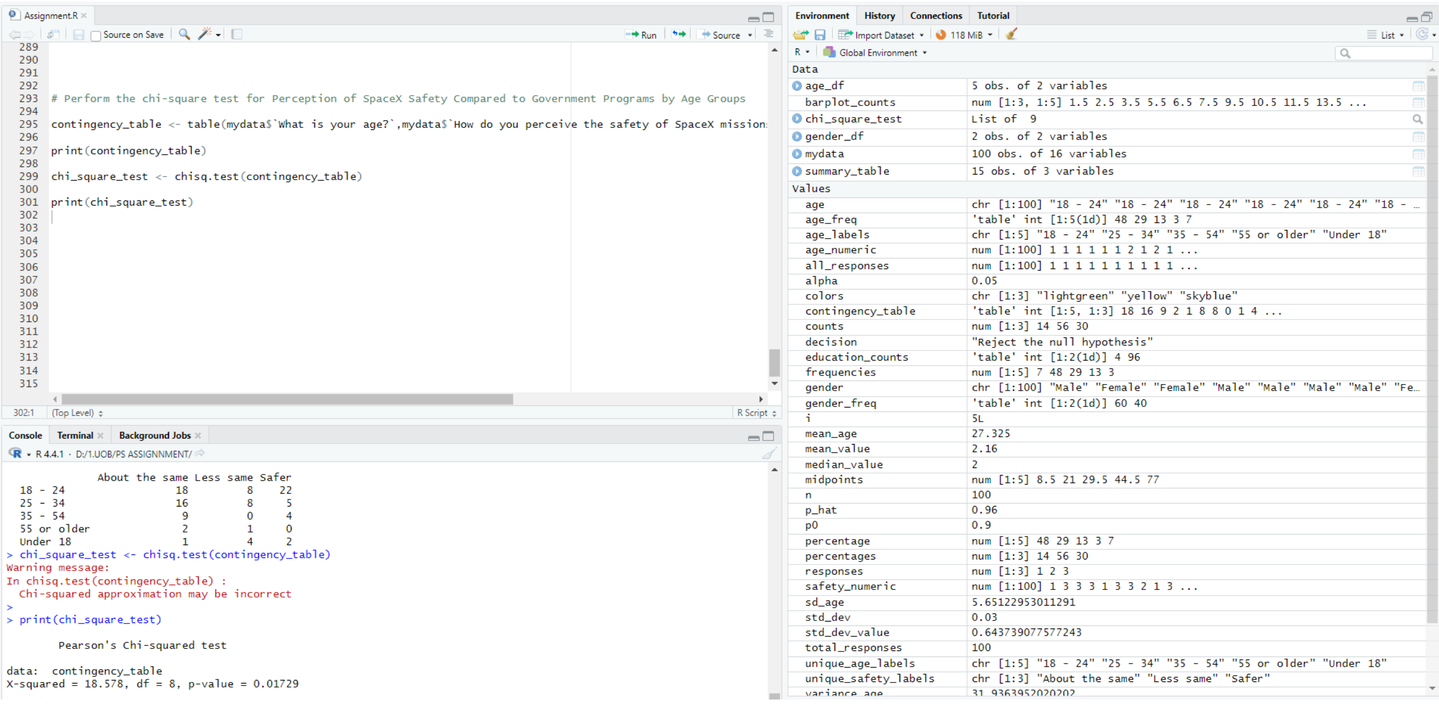


# Gender Distribution in TreeMap
install.packages("treemap")
library(treemap)
gender <- mydata$`What is your gender?`
gender_df <- as.data.frame(table(gender))
colors <- c("#FFC0CB", "#ADD8E6")
treemap(gender_df,
index = "gender",
vSize = "Freq",
vColor = "Freq",
draw = TRUE,
title = "Gender Distribution Based on Survey Responses",
palette = colors,
border.col = "black")
Gender Distribution Based on Survey Responses
Female
Male


#Perception of SpaceX Safety Compared to Government Programs by Age Groups
mydata$AgeGroup <- factor(mydata$`What is your age?`, levels = c("Under 18", "18 - 24
mydata$SafetyPerception <- factor(mydata$`How do you perceive the safety of SpaceX missions compared to tradit
summary_table <- as.data.frame(table(mydata$AgeGroup, mydata$SafetyPerception))
print(summary_table)
colors <- c("lightgreen", "yellow", "skyblue")
barplot_counts <- barplot(
matrix(summary_table$Freq, nrow = length(levels(mydata$SafetyPerception)), byrow = TRUE),
beside = TRUE,
col = colors,
names.arg = levels(mydata$AgeGroup),
legend.text = levels(mydata$SafetyPerception),
args.legend = list(title = "Safety Perception", x = "topright"),
xlab = "Age Group",
ylab = "Count of Responses",
main = "Perception of SpaceX Safety Compared to Government Programs by Age Groups"
)
text(
x = barplot_counts,
y = matrix(summary_table$Freq, nrow = length(levels(mydata$SafetyPerception)), byrow = TRUE),
label = matrix(summary_table$Freq, nrow = length(levels(mydata$SafetyPerception)), byrow = TRUE),
pos = 3, # Position above each bar
cex = 0.8, # Text size
col = "black"
> # Add exact count labels above each bar
> abline(h=0)
Perception of SpaceX Safety Compared to Government Programs by Age Group
Safety Perception
About the same
Less same
Safer
Count of Responses
Age Group
Under 18
18 - 24
25 - 34
35 - 54
55 or older
22


# Scatter plot of Age vs. Safety Perception
age_numeric <- as.numeric(as.factor(mydata$`What is your age?`))
safety_numeric <- as.numeric(as.factor(mydata$`How do you perceive the safety of SpaceX missions compared to t
plot(
jitter(age_numeric),
jitter(safety_numeric),
xlab = "Age Group",
ylab = "Perception of Safety",
main = "Scatter Plot of Age vs. Perception of SpaceX's Mission Safety",
col = "red",
pch = 16,
xaxt = "n",
yaxt = "n"
)
unique_safety_labels <- levels(as.factor(mydata$`How do you perceive the safety of SpaceX missions compared to
axis(2,
at = 1:length(unique_safety_labels),
labels = unique_safety_labels
)
unique_age_labels <- levels(as.factor(mydata$`What is your age?`))
axis(1,
at = 1:length(unique_age_labels),
labels = unique_age_labels
)
mean_age 27.325
mean_value 2.16
median_value 2
midpoints num [1:5] 8.5 21 29.5 44.5 77
percentage num [1:5] 48 29 13 3 7
percentages num [1:3] 14 56 30
responses num [1:3] 1 2 3
safety_numeric num [1:100] 1 3 3 3 1 3 3 2 1 3 ...
sd_age 5.65122953011291
std_dev_value 0.643739077577243
total_responses 100
unique_age_labels chr [1:5] "18 - 24" "25 - 34" "35 - 54" "55 or older" "Under 18"
unique_safety_labels chr [1:3] "About the same" "Less same" "Safer"
Scatter Plot of Age vs. Perception of SpaceX's Mission Safety
Perception of Safety
Safer
Less same
Age Group
18 - 24
25 - 34
35 - 54
55 or older
Under 18


Assignment.R
Source on Save
Run
Source
# Z test
n <- 100
x <- 96
p_hat <- x / n
p0 <- 0.90
alpha <- 0.05
# Step 3: Calculate the standard deviation of the sample proportion
std_dev <- sqrt(p0 * (1 - p0) / n)
# Step 4: Calculate the test statistic (Z)
z <- (p_hat - p0) / std_dev
# Step 5: Critical Z-value for one-tailed test at 5% significance level
z_critical <- qnorm(1 - alpha)
# Step 6: Decision
if (z > z_critical) {
decision <- "Reject the null hypothesis"
} else {
decision <- "Fail to reject the null hypothesis"
}
# Display the results
cat("Sample Proportion (p̂):", p_hat, "\n")
cat("Hypothesized Proportion (p0):", p0, "\n")
cat("Standard Deviation:", std_dev, "\n")
cat("Test Statistic (Z):", z, "\n")
cat("Critical Z-Value:", z_critical, "\n")
cat("Decision:", decision, "\n")
282:1 (Top Level) R Script
Console Terminal Background Jobs
R 4.4.1 · D:/1.UOB/PS ASSIGNMENT/
> # Step 6: Decision
> if (z > z_critical) {
+ decision <- "Reject the null hypothesis"
+ } else {
+ decision <- "Fail to reject the null hypothesis"
+ }
> # Display the results
> cat("Sample Proportion (p̂):", p_hat, "\n")
Sample Proportion (p̂): 0.96
> cat("Hypothesized Proportion (p0):", p0, "\n")
Hypothesized Proportion (p0): 0.9
> cat("Standard Deviation:", std_dev, "\n")
Standard Deviation: 0.03
> cat("Test Statistic (Z):", z, "\n")
Test Statistic (Z): 2
> cat("Critical Z-Value:", z_critical, "\n")
Critical Z-Value: 1.644854
> cat("Decision:", decision, "\n")
Decision: Reject the null hypothesis
Environment History Connections Tutorial
Import Dataset 118 MiB List
R Global Environment
gender_df 2 obs. of 2 variables
mydata 100 obs. of 16 variables
summary_table 15 obs. of 3 variables
Values
age chr [1:100] "18 - 24" "18 - 24" "18 - 24" "18 - 24" "18 - 24" "18 - ...
age_freq 'table' int [1:5(1d)] 48 29 13 3 7
age_labels chr [1:5] "18 - 24" "25 - 34" "35 - 54" "55 or older" "Under 18"
age_numeric num [1:100] 1 1 1 1 1 1 2 1 2 1 ...
all_responses num [1:100] 1 1 1 1 1 1 1 1 1 1 ...
alpha 0.05
colors chr [1:3] "lightgreen" "yellow" "skyblue"
contingency_table 'table' int [1:5, 1:3] 18 16 9 2 1 8 8 0 1 4 ...
counts num [1:3] 14 56 30
decision "Reject the null hypothesis"
education_counts 'table' int [1:2(1d)] 4 96
frequencies num [1:5] 7 48 29 13 3
gender chr [1:100] "Male" "Female" "Female" "Male" "Male" "Male" "Male" "Fe...
gender_freq 'table' int [1:2(1d)] 60 40
i 5L
mean_age 27.325
mean_value 2.16
median_value 2
midpoints num [1:5] 8.5 21 29.5 44.5 77
n 100
p_hat 0.96
p0 0.9
percentage num [1:5] 48 29 13 3 7
percentages num [1:3] 14 56 30
responses num [1:3] 1 2 3
safety_numeric num [1:100] 1 3 3 3 1 3 3 2 1 3 ...
sd_age 5.65122953011291
std_dev 0.03
std_dev_value 0.643739077577243
total_responses 100
unique_age_labels chr [1:5] "18 - 24" "25 - 34" "35 - 54" "55 or older" "Under 18"
unique_safety_labels chr [1:3] "About the same" "Less same" "Safer"
variance_age 31.9363952020202
variance_value 0.4144
x 96
z 2
z_critical 1.64485362695147


Assignment.R
Source on Save
Run
Source
# Perform the chi-square test for Perception of SpaceX Safety Compared to Government Programs by Age Groups
contingency_table <- table(mydata$`What is your age?`,mydata$`How do you perceive the safety of SpaceX mission
print(contingency_table)
chi_square_test <- chisq.test(contingency_table)
print(chi_square_test)
302:1 (Top Level) R Script
Console Terminal Background Jobs
R 4.4.1 · D:/1.UOB/PS ASSIGNMENT/
About the same Less same Safer
18 - 24 18 8 22
25 - 34 16 8 5
35 - 54 9 0 4
55 or older 2 1 0
Under 18 1 4 2
> chi_square_test <- chisq.test(contingency_table)
Warning message:
In chisq.test(contingency_table) :
Chi-squared approximation may be incorrect
> print(chi_square_test)
Pearson's Chi-squared test
data: contingency_table
X-squared = 18.578, df = 8, p-value = 0.01729
Environment History Connections Tutorial
Import Dataset 118 MiB List
R Global Environment
Data
age_df 5 obs. of 2 variables
barplot_counts num [1:3, 1:5] 1.5 2.5 3.5 5.5 6.5 7.5 9.5 10.5 11.5 13.5 ...
chi_square_test List of 9
gender_df 2 obs. of 2 variables
mydata 100 obs. of 16 variables
summary_table 15 obs. of 3 variables
Values
age chr [1:100] "18 - 24" "18 - 24" "18 - 24" "18 - 24" "18 - 24" "18 - ...
age_freq 'table' int [1:5(1d)] 48 29 13 3 7
age_labels chr [1:5] "18 - 24" "25 - 34" "35 - 54" "55 or older" "Under 18"
age_numeric num [1:100] 1 1 1 1 1 1 2 1 2 1 ...
all_responses num [1:100] 1 1 1 1 1 1 1 1 1 1 ...
alpha 0.05
colors chr [1:3] "lightgreen" "yellow" "skyblue"
contingency_table 'table' int [1:5, 1:3] 18 16 9 2 1 8 8 0 1 4 ...
counts num [1:3] 14 56 30
decision "Reject the null hypothesis"
education_counts 'table' int [1:2(1d)] 4 96
frequencies num [1:5] 7 48 29 13 3
gender chr [1:100] "Male" "Female" "Female" "Male" "Male" "Male" "Male" "Fe...
gender_freq 'table' int [1:2(1d)] 60 40
i 5L
mean_age 27.325
mean_value 2.16
median_value 2
midpoints num [1:5] 8.5 21 29.5 44.5 77
n 100
p_hat 0.96
p0 0.9
percentage num [1:5] 48 29 13 3 7
percentages num [1:3] 14 56 30
responses num [1:3] 1 2 3
safety_numeric num [1:100] 1 3 3 3 1 3 3 2 1 3 ...
sd_age 5.65122953011291
std_dev 0.03
std_dev_value 0.643739077577243
total_responses 100
unique_age_labels chr [1:5] "18 - 24" "25 - 34" "35 - 54" "55 or older" "Under 18"
unique_safety_labels chr [1:3] "About the same" "Less same" "Safer"