

Space Missions Analysis – Project Report

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Tools: Python, Pandas, Matplotlib, Seaborn, Jupyter Notebooks

1. Introduction

This project analyzes historical data on global space missions using Python. The goal is to identify trends and extract insights about the frequency, cost, timing, and outcomes of space launches conducted by different organizations over time.

2. Research Questions

The analysis focuses on answering the following key questions:

1. Which organization launched the most space missions in a given year?
2. How many launches were carried out per year?
3. How has the cost of space missions varied over time?
4. Which months are the most popular for launches?
5. Have space missions become safer, or have failure rates remained constant?

3. Dataset Overview

- Source: <https://www.kaggle.com/datasets/sefercanapaydn/mission-launches>
- Fields: Organization, Location, Date, Detail, Rocket Status, Price, Mission status,
- Period Covered: 1957–2023

4. Technologies Used

- Programming Language: Python 3
- Data Manipulation: Pandas
- Visualization: Matplotlib, Seaborn
- Environment: Jupyter Notebooks

5. Methodology

1. Data Cleaning:

- Converted the Date column to datetime format and extracted Year and ordered Month for temporal analysis.
- Cleaned and renamed columns (id, removed Unnamed: 0) for clarity.
- Split the Detail column into Rocket and Mission, then removed the original
- Converted the Price column to numeric and applied a multi-step imputation strategy using group means and median values.
- Rounded all price values to two decimal places for consistency.

2. Exploratory Data Analysis (EDA):

- Grouped data by year, organization, and outcome
- Generated visualizations to identify trends and anomalies

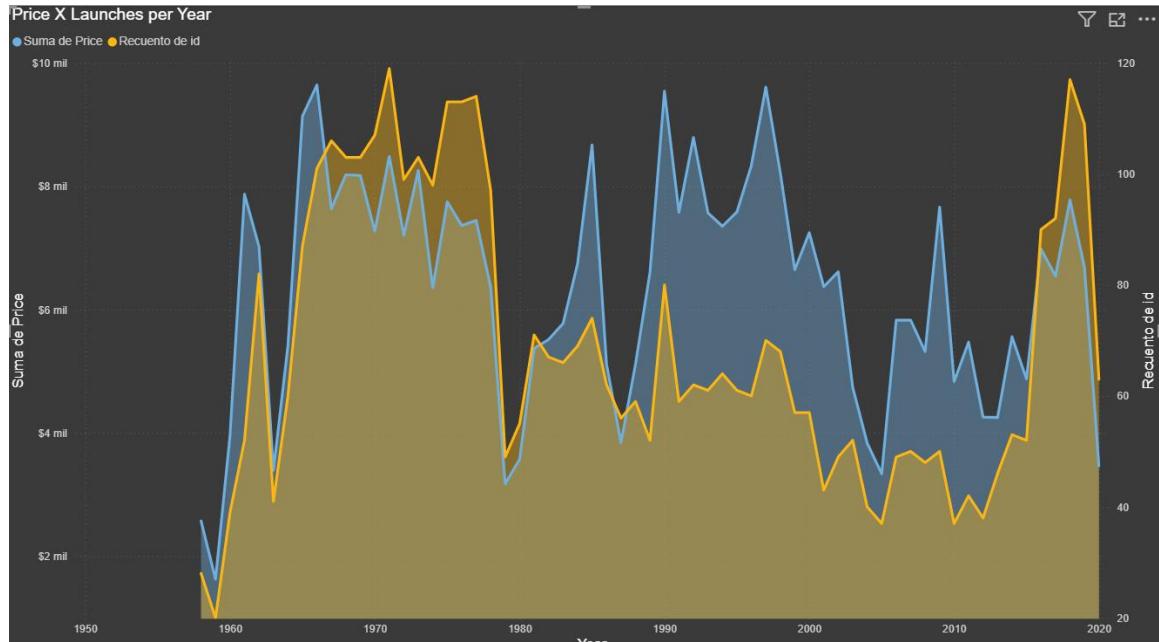
3. Visualization:

- Bar charts, time series to visualize insights

6. Key Findings

- 🚀 Top Organizations by Launch Count: RVSN USSR, Arianespace, General Dynamics
- 📈 Launch Trends Over Time: Consistent growth since 1967.
- 💰 Cost Evolution: Early missions were highly expensive; some modern launches are more cost-effective.
- 🗓️ Seasonality: Launches tend to peak in December and June
- ⚙️ Mission Reliability: Failure rates have decreased over time, indicating improved safety and technology.

7. Visual Highlights



Based on the analysis and the accompanying chart, three distinct periods can be identified in the evolution of space mission activity:

1st Period (1957–1978), 2nd Period (1979–2015), and 3rd Period (2015–2020).

First Period (1957–1978): Rapid Growth

This phase was characterized by a steep increase in launch activity — from around 20 launches in the early years to a peak of 119. This growth reflects the intense competition of the Space Race era, with major investments from both the United States and the Soviet Union.

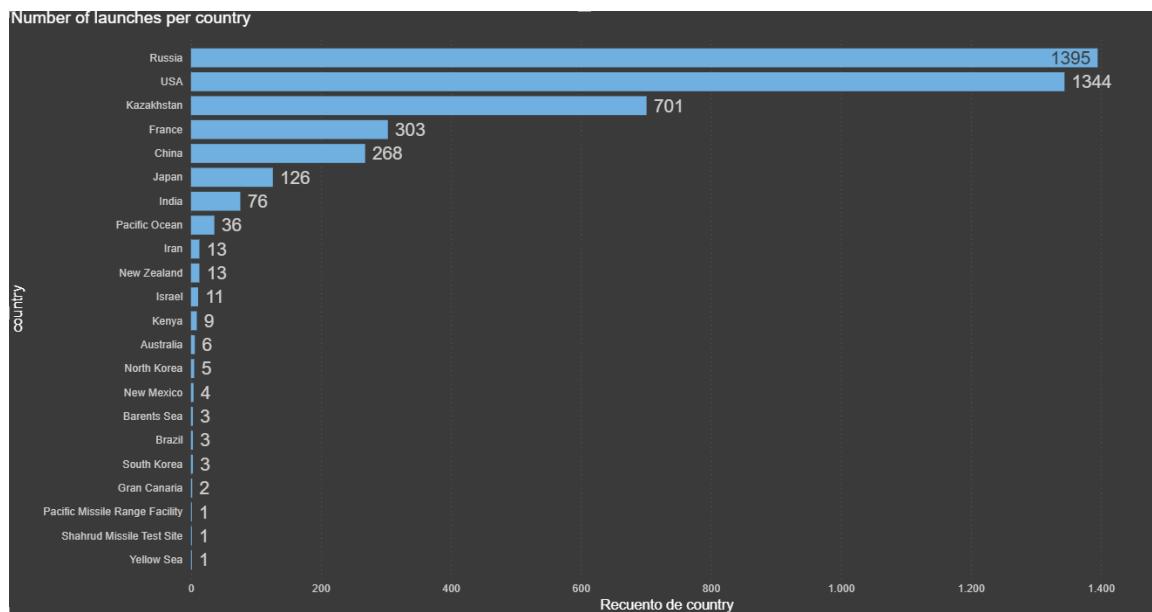
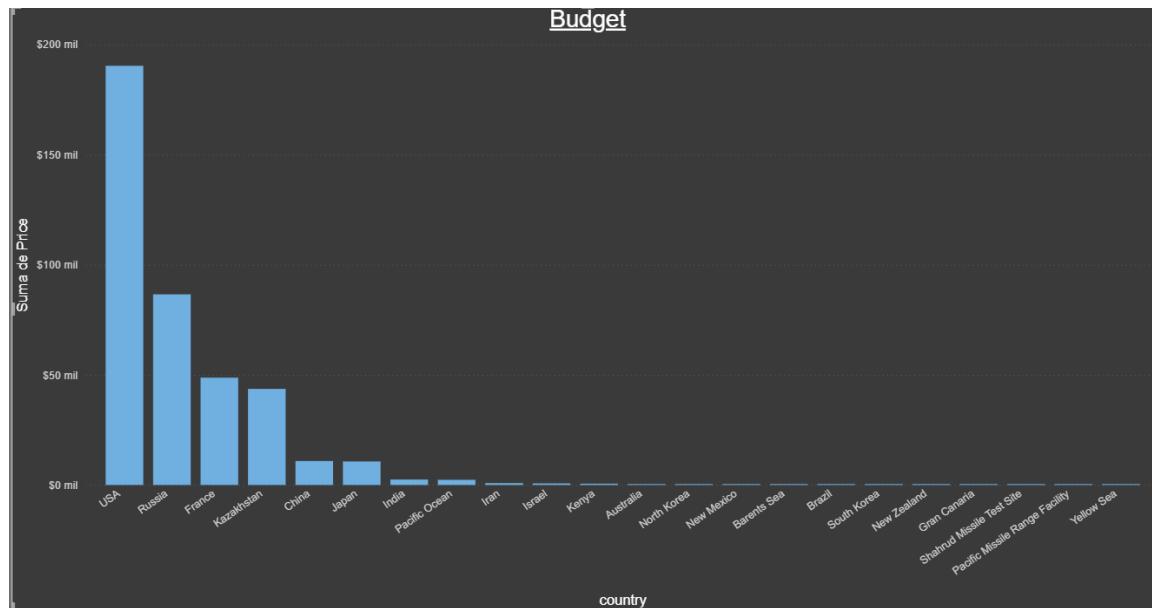
Second Period (1979–2015): Decline and Stabilization

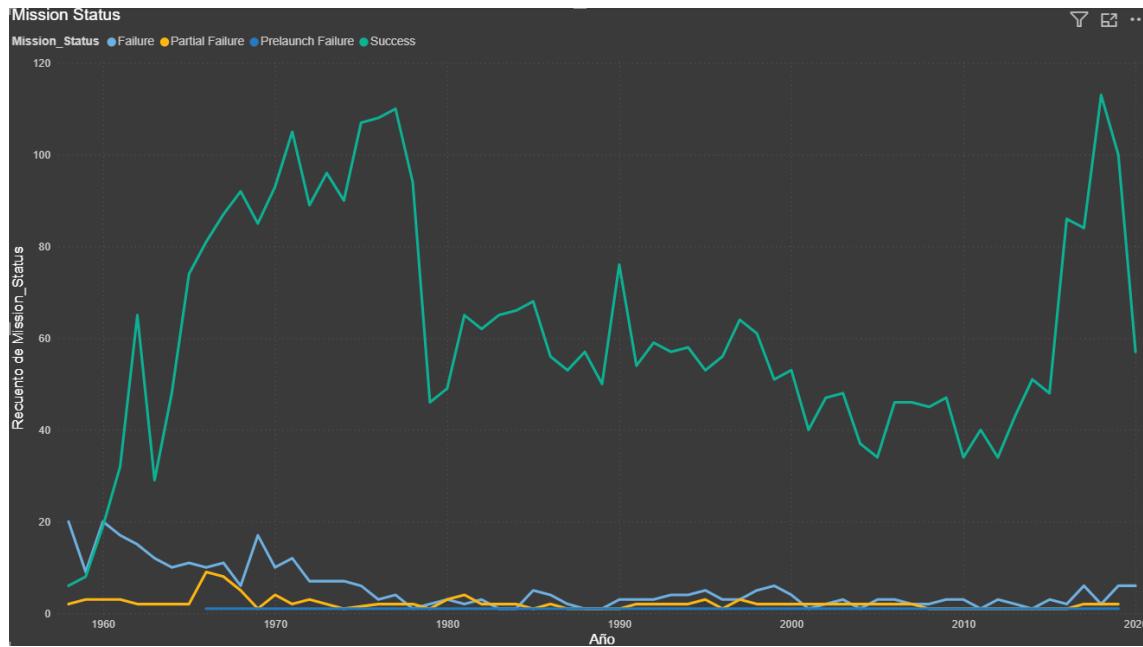
Following the historic Apollo-Soyuz mission, which marked the first international crewed spaceflight between the US and the USSR, a new era of cooperation emerged. This led to a significant drop in the number of launches.

Despite the decline in missions, the total annual costs remained high — suggesting increased complexity and technological advancement in spacecraft, resulting in higher per-mission costs.

Third Period (2015-2020): The SpaceX Revolution

A turning point occurred with the successful launch and landing of **SpaceX's Falcon 9** in 2015. This milestone proved that rocket reusability was feasible, significantly reducing launch costs. As a result, space missions became more accessible, sparking a resurgence in launch frequency and opening new commercial opportunities in the space industry.





8. Conclusion

The evolution of space missions over the decades reflects a dynamic interplay between geopolitical motivations, technological advancement, and commercial innovation. While the early years were dominated by political rivalry, the modern era is increasingly driven by cost-efficiency and private sector involvement — setting the stage for a more accessible and sustainable future in space exploration.