



## Challenges in Lunar Landing Missions

**For Prelims:** Challenges in Lunar Landing Missions, [Russia's Luna-25](#), [Soviet Union](#), [India's Chandrayaan-3](#), Lunar South Pole, International Lunar Research Station, [ISRO's Chandrayaan-2](#).

**For Mains:** Challenges in Lunar Landing Missions.

**Source:** TH

### Why in News?

Recently, [Russia's Luna-25](#) crashed on the Moon's surface, ending its first mission to the lunar surface 47 years after the last landing by the **former** [Soviet Union](#).

- This leaves [India's Chandrayaan-3](#) on course to become the first spacecraft to land **near the Lunar South Pole**.
- Russia's Luna-25 marked the resumption of lunar interest and plans to continue the Luna series.

### What is the Luna-25 Mission?

- **About:**
  - The Luna 25 mission, originally named **Luna-Glob**, underwent over two decades of development before joining the historic Luna series initiated in 1976.
  - The mission aimed to **secure Russia's access to the Moon's surface** amid its significance in space exploration and geopolitical rivalry.
    - While Russia and China lead the [International Lunar Research Station \(ILRS\)](#), the U.S. heads the Artemis Accords.
- **Failure:**
  - The Luna 25 spacecraft encountered a technical glitch, surpassing its **operational limits**.
  - The failure appears linked to an **attempt to shift its circular orbit to a lower pre-landing orbit**.
  - **Excessive thrust during this maneuver caused a trajectory deviation**, causing the craft to crash onto the Moon's surface.
    - Roscosmos lost communication during this critical event.
  - Due to the Russia-Ukraine war, Russia lost its privileges to **use satellite tracking systems operated by countries** in different parts of the world. Roscosmos could contact Luna 25, and receive signals from the spacecraft, only at three stations: two in **Russia and one in Russian-occupied Crimea**.
    - ISRO, unlike Russia, is receiving help from [National Aeronautics and Space Administration \(NASA\)](#) and the European Space Agency (ESA) to track **Chandrayaan 3 around the moon**.

### What are the Complexities in Successful Lunar Landing?

- **Complexity of Lunar Descent:**

- Lunar landings involve a **challenging descent from lunar orbit to the Moon's surface**, often referred to as the "**15 minutes of terror.**"
- The complexity arises from the **need to precisely control the spacecraft's speed, trajectory, and altitude** during this crucial phase.
- **Historical Perspective:**
  - Despite more than 20 successful landings, including six with human crew, the **technology remains imperfect.**
    - Most successful lunar landings occurred within a **decade between 1966 and 1976**, with three Chinese landings in the past decade as exceptions.
    - Lunar landing technology during the 1960s and 1970s was far from perfected, with a 50% success rate among 42 attempts.
  - Contemporary lunar missions deploy safer, cost-efficient, and fuel-efficient technologies **but require testing and validation.**
- **Complex Propulsion:**
  - Lunar landing involves **a sequence of controlled maneuvers**, from deceleration to final touchdown. Precise propulsion systems must be employed to manage speed and altitude accurately.
- **Thermal Challenges:**
  - Extreme temperature variations on the Moon, from scorching heat to freezing cold, pose challenges for spacecraft systems. Thermal protection and insulation are critical to prevent equipment malfunctions.

## What are the Recent Failures and Successes in Lunar Landing Attempts?

- **Failure:**
  - Missions from **India, Israel, Japan, and Russia** all faced challenges during the landing process, resulting in crashes on the Moon's surface.
    - **ISRO's Chandrayaan-2:** Malfunctions **prevented the desired speed levels from being achieved.**
    - **Beresheet (Israel), Hakuto-R (Japan):** Different kinds of malfunctions disrupted landing plans.
- **Successes:**
  - China's Chang'e-3, Chang'e-4, and Chang'e-5 missions achieved successful lunar landings.

## Way Forward

- India's Chandrayaan-3 exemplifies the importance of learning from failures. After the Chandrayaan-2 setback.
- While recent failures underscore the **complexity of soft-landing on the Moon**, they also reflect the determination of space agencies **to push boundaries and advance the field of lunar exploration.**
- The lessons learned from these attempts **will contribute to the development of more reliable and successful lunar landing** technologies in the future.