

# Data | Chandrayaan-3 mission: How tough is it to land on the moon?

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A screen grab taken from ISRO's live webcast on August 6, 2019 shows Vikram, the lander of the Chandrayaan-2 mission, before it is supposed to land on the Moon. The lander lost contact with the earth just minutes before lunar touchdown. | Photo Credit: AFP

Space is hard. Moon missions are a testament to this phrase. Data show that historically over 40% of moon missions have failed. If we consider only those missions which involved a robotic lander (a spacecraft performing a controlled landing on the lunar surface), the failure rate sharply increases to over 60%. The

failure rates of 'sample return' missions, which collect samples from the moon and bring them back to the earth, is even higher at 67% as such missions are complex and riskier.

The Indian Space Research Organisation (ISRO) is no stranger to this fact. In September 2019, 'Vikram', the lander of the Chandrayaan -2 mission, lost contact with the earth and went blank minutes before lunar touchdown. The mission of the lander and the rover 'Pragyan', was declared a failure. The orbiter mission was a success as the orbiter was placed in the intended orbit.



**Chandrayaan 3**, largely a replica of Chandrayaan -2, was launched by ISRO on July 14 and is expected to land on the moon on August 23-24 this year. Chandrayaan -3’s lander now has stronger legs, enhanced power, and an upgraded landing sequence, with which it aims soft- land on the moon. Lander missions are among the hardest to execute.

Table 1 | *The table shows the failure, partial failure, and success percentages of completed lunar missions undertaken by all space agencies and other operators since 1958.*

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Sample return and robotic- lander missions have the highest failure rates of 66.7% and 62.8% respectively. Interestingly, the seven crewed lander missions – all part of NASA’s Apollo programme – had a 100% success rate. The mission of Apollo 13’s lunar module – Aquarius – is considered a success despite not achieving its primary objective of landing on the moon as it helped return the crew safely to the earth.

Impactor missions, in which a spacecraft or a part of it is deliberately made to collides with the moon in order to study the resulting crater or dust plume, also have a high failure rate of 56.3%. In contrast, the orbiter missions (placing a spacecraft in lunar orbit) and flyby missions (coming close to the moon to gather data or take images, but not entering the orbit) have enjoyed fairly lower failure rates of 36.7% and 24.6% respectively.

Table 2 | *The table shows the failure, partial failure, and success of completed lunar missions undertaken by all space agencies and other operators since 1958 as an absolute number.*

Note that given their complex nature, sample return and robotic- lander missions have been undertaken less often than orbiter missions, which have the lowest failure percentage.

Table 3 | *The table shows the total number of lunar missions completed by decade. It also lists the failure percentages of such missions by type.*

*Scroll horizontally to view the number of lunar missions in recent decades*

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The failure rate includes partial failures in which some objectives were achieved, but the mission was not completed. The 1950s had a very high failure rate across mission types. All the orbiter missions failed. The overall failure rate was 84.6%. The 1960s saw the highest number of moon missions (74) for any decade thus far. But the overall failure rate remained relatively high at 62.2%. However, note that in the 1960s, the orbiter failure rate reduced to just 40%, hinting at spaceflight agencies getting better at such missions.

Chart 4 | *The chart shows the number of lunar missions.*

The 1970s were much better with 40 missions and just a 25% failure rate. In general, the number of moon missions dropped in the following decades. The 2000s stood out as all the missions succeeded. The 2010s also had a much lower failure rate of 22%. But the number of unsuccessful missions went up again in the following decade and the overall failure rate rose to 47.1%. Even half the flyby missions have failed in this time.

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Source: Various space agencies

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Published - July 27, 2023 04:06 pm IST