

UDC 629.785

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(Taldykorgan, Kazakhstan)**WHAT DECIDES HOW LONG A LANDER WORKS ON ANOTHER WORLD?
SURFACE LIFETIMES OF 55 LANDERS ON THE MOON, VENUS, MARS, TITAN
AND SMALL BODIES IN THE GCAT CATALOGUE, 1966-2025**

Abstract: Landers that reach the surface of another world have kept working there from under two minutes to several years. This study asks what decides that time: the environment of the target body, the era, the landing method or the country that built the lander. All 55 landers in Jonathan McDowell's public GCAT lander catalogue (version of 11 October 2026) that reached the surface and kept transmitting for a measurable time were analysed, and each was also coded by whether its stay was planned to be short or its job ended once a rover was delivered. Surface time is most strongly associated with the target body: all 11 Venus landers stopped within 20 to 127 minutes, the median lunar lander worked 3.1 days and the median Mars lander 94 days (Kruskal-Wallis across the three bodies, $p < 0.001$). Three apparent effects in the full table largely reflect where landers went: all four landings of the 1980s and 10 of the 12 landings the catalogue codes LP (parachute assisted) were on Venus, and the 184-fold gap between Soviet and American landers falls to 13-fold without Venus and to 4-fold on the Moon alone. On the Moon a second factor appears: 13 of the 14 shortest lunar surface times belong to landers coded as ended by design (12 that ended as planned and the damaged sample-return lander Luna-23), and every lander whose ascent stage left the Moon, American, Soviet or Chinese, stayed between 0.9 and 3.1 days before it did. Among the 14 lunar landers whose surface phase was not ended by design, seven stopped within about 15 days and seven worked a month or more; only two, Chang'e-3 (2,460 days) and Chang'e-4 (at least 2,278 days and still listed as operating), lasted years.

Keywords: planetary landers, surface lifetime, Venus, Moon, Mars, lunar night, mission design, GCAT

Introduction

A spacecraft that lands on another world meets conditions that nobody could measure fully before launch, and how long it survives there is limited by power, heat and the margin its designers left. The bodies differ enormously. The surface of Venus has a temperature of about 450 °C and a pressure of about 90 atmospheres, which makes it, in Landis's words, "a hostile place for operation of a probe" [1]. On Mars, dust slowly covers solar panels: for the InSight lander, a simple model with a steady loss of about 0.28% of peak solar-array output per Martian day (sol) appears to reproduce the observed power history over its first 200 sols [2], and NASA declared the mission over in December 2022, after engineers concluded that the lander's solar-powered batteries had run out of energy as its dusty panels produced less and less power [3]. Spacecraft also stop for reasons that have nothing to do with the environment: Viking 1, whose lander, like that of Viking 2, carried two radioisotope thermoelectric generators, operated on Mars until 11 November 1982, when a faulty command sent from Earth interrupted communications [4]. On Titan, the Huygens probe landed softly after a parachute descent of

almost 2.5 hours [5]. On the Moon, the ALSEP stations left by the Apollo 12 and 14-17 astronauts drew about 70 W from radioisotope thermoelectric generators "for continuous day and night operation" and returned data until NASA terminated support operations on 30 September 1977 [6].

These cases show many different causes, but each describes one mission. When many landers are put side by side, simple comparisons can mislead, because the bodies, the decades, the landing methods and the countries are tangled together. A table of landers might suggest that technology collapsed in the 1980s, that parachutes are worse than rocket engines, or that Soviet landers were far worse than American ones, when each pattern could instead come from where those landers went or from what they were sent to do.

This study uses the public GCAT lander catalogue [7, 8] to answer one question: what decides how long a lander works on the surface of another body, the environment of the body, the era, the landing method or the country? The author chose this question between 3 and 16 September 2026 from a menu of five questions prepared by his mentor. That menu already showed the median surface times for Venus, the Moon and Mars, computed on 3 September, and its first option already stated the expected answer, that the environment decides almost everything. The study therefore tests a pattern that was visible before the question was chosen, and it asks whether that pattern survives a closer look.

Materials and Methods

Data. The General Catalog of Artificial Space Objects (GCAT) is compiled by the astrophysicist Jonathan McDowell and released under a CC-BY 4.0 licence [7]. Its lander catalogue lists landings, impacts and atmospheric entries on the Moon and planets. The file used here, *landercat.tsv*, was downloaded on 11 October 2026 (GCAT release 1.8.8, data update of 11 October 2026) and has 469 rows. The catalogue's documentation [8] defines each field. The status code L means "Landing, continued to operate after touchdown"; a second letter C marks cargo attached to a parent lander, such as a rover or an ascent vehicle. The surface time (Dur) is the "time operating on surface", the difference between the date the object contacted the surface and the date it "stopped transmitting from the target body's surface, either because it stopped working or because it was launched back into space" [8]. The catalogue's end date is therefore the last signal it records, which can differ by days from the date given in a mission account: NASA dates the end of Viking 1 to 11 November 1982 [4] and the last Pathfinder data to 27 September 1997 [9], while the catalogue records 20 November 1982 and 7 October 1997. The catalogue values are used throughout.

Sample. Of the 469 rows, 64 have status L. Eight of them have a recorded surface time of zero and were excluded; among them are the descent stages of Mars Science Laboratory and Mars 2020, which lowered their rovers to the surface on cables and flew away, and Mars-6, whose contact was lost at landing. One further row was excluded under the same rule. For the Rosetta orbiter, which ended its mission by descending onto comet 67P, the catalogue gives 10:39:34 as the landing time and 11:19 as the end. ESA expected the impact at about 10:40 UTC and its confirmation on Earth, after a one-way signal travel time of 40 minutes, at about 11:20 UTC, and it arranged for Rosetta's main transmitter to be turned off as soon as the spacecraft hit the surface [10]. The 40 minutes are therefore signal travel time, and Rosetta's surface time is zero. The remaining 55 landers form the sample. Before this exclusion they are the same 56 landers, with the same surface times, as in the working table the author received on 16 September 2026, which was built from the catalogue on 3 September 2026. Cargo objects (status LC), such as rovers and the Apollo experiment packages, are not part of the sample because

they did not land on their own. Not every lander in the sample was built to survive touchdown: the American Pioneer Venus Day Probe was not expected to survive its impact, yet it transmitted from the surface for 67 minutes 37 seconds [11] (67.7 minutes in the catalogue).

Variables. For each lander the target body, the country (the catalogue's state code), the decade of landing and the landing method were taken from the catalogue. Landing methods are the catalogue's lander-type codes: thrusters (L), airbags (LA), parachute assisted (LP, "Lander, parachute assisted landing" [8]), a lander designed to survive a low-velocity impact (LI, which the catalogue also assigns to the Day Probe), a hopping rover that landed by impact (LR), and an orbiter that was not designed to land (LO) [8]. The codes name the main landing aid, not the last stage: the later Venera landers coded LP dropped their parachutes high in the atmosphere, at 46 km for Venera-11 and 47 km for Venera-14, and fell the rest of the way braked only by a disc-shaped airbrake or by the atmosphere [12, pp. 128, 151, 157], and Mars landers coded L or LA also descended on parachutes before thrusters or airbags took over, as documented for Mars Pathfinder [9; 12, p. 195], Spirit [12, pp. 223-224] and Phoenix [12, p. 251].

Mission role. After the author noticed that Luna-17 and Luna-21 worked only for hours because they were transport platforms for the Lunokhod rovers, landers whose surface phase was ended by design were separated from landers whose surface phase was not. A surface phase was coded as ended by design in four cases. (1) The lander carried an ascent vehicle (a cargo row with lander type AV and the same landing time): it was a sample-return or crewed lander whose stay on the surface was planned to be short, and its surface phase is counted as ended by design. For most of these landers the catalogue's surface time ends when the ascent stage took off; for Chang'e-5 and Chang'e-6 the catalogue's lander times, which run past the ascent, are used. Luna-23 belongs to this group: it was a sample-return lander damaged on touchdown, so its ascent stage never left, and controllers kept contact under a makeshift plan until 9 November 1974 [12, pp. 123-124]. (2) The catalogue describes a sampling touchdown after which the spacecraft took off (Hayabusa on Itokawa). (3) The lander type is LO, an orbiter not designed to land that descended at the end of its mission (NEAR Shoemaker on Eros). (4) The lander carried a rover (a cargo row with lander type RO and the same landing time) and a source lists no scientific instruments on the lander itself, so the lander's job ended once the rover was on the surface. Fifteen landers carried rovers. Apollo 15, 16 and 17 are coded under rule (1) because they also carried ascent vehicles, and the other twelve were judged one by one. Five were coded as delivery platforms: Luna-17, whose listed instruments were all on the Lunokhod 1 rover and whose descent stage carried ramps for the rover to drive off [12, p. 97]; Luna-21, whose listed instruments are rover instruments such as an odometer and a penetrometer [12, p. 113]; the landing platforms of the Spirit and Opportunity rovers, for which only the rovers' instruments are listed [12, pp. 222, 225]; and the Tianwen-1 lander, because the 13 science payloads of that mission were mounted on the orbiter and the rover [13]. Seven were coded as not ended by design because sources list instruments of their own: the Mars Pathfinder lander, which returned more than 16,500 images [9], Mars-3 [12, p. 102], Chang'e-3 [12, p. 292; 14, p. 85], Chang'e-4 [15], Chandrayaan-3 Vikram [16], SLIM, whose Multi-Band Camera made spectral observations of rocks on the surface [17], and IM-2 Athena, which carried NASA's PRIME-1 drill and mass spectrometer [18]. The effect of these judgement cases is reported as a sensitivity check.

Lunar day and night. The Moon appears to orbit the Earth every 29 days [19], and a lunar day and a lunar night each last about 14 Earth days [20]. A lunar lander that worked for 29 days or more must therefore have kept working, or started working again, after at least one

lunar night. In the data no lunar lander whose surface phase was not ended by design has a surface time between 14.6 and 34.6 days, so any threshold in that interval gives the same result.

Analysis. The steps followed the order the mentor set out in the chat with the author: first the medians by body; then the three apparent effects of era, landing method and country, computed on all landers, again without Venus, and again on the Moon only; then the mission-role coding; then a comparison with the author's own expectations. The medians by body and the three apparent effects had already been computed and shown to the author on 3 September, before the question was chosen. Medians are used because surface times range over more than six orders of magnitude. Differences between bodies were tested with the Kruskal-Wallis test and the difference between the two role groups on the Moon with the exact Mann-Whitney test. Because the catalogue is a complete list of landers rather than a random sample, these p-values are read only as a measure of how unusual a split would be if the group labels were assigned at random. All computations were done in Python 3.13 with SciPy 1.18.

Censoring. Chang'e-4 has no end date in the catalogue, which still listed it as operating at the update of 11 October 2026. Its recorded 2,278 days correspond to the period up to about 30 March 2025; if it was still working at the update, its surface time would by then be 2,838 days. Its value is therefore a lower limit. Huygens was still transmitting when the Parkes radio telescope set, over three hours after landing [21]; the catalogue's end, 3.5 hours after landing, is later than that, and no source checked says when its transmitter stopped, so this value is uncertain. Seven landers have end dates that the catalogue marks as approximate, including Chang'e-3 ("2020 Sep?").

Results

Surface time by body. The 55 landers include 28 on the Moon, 11 on Venus, 9 on Mars, 3 on the asteroid Ryugu and one each on Titan, comet 67P, the asteroid Eros and the asteroid Itokawa. Surface times range from under two minutes for the Soviet Mars-3 lander of 1971 (the catalogue rounds its time to 0.001 days and its comment gives 110 seconds of transmission, while Siddiqi gives 14.5-20 seconds of image transmission [12, p. 102]) to 2,460 days for the Chinese Chang'e-3 lander of 2013 (Figure 1). Table 1 gives the median for each body.

Table 1 - Surface time of the 55 landers by target body (GCAT lander catalogue, 11 October 2026)

Body	Landers	Median surface time	Shortest	Longest
Venus	11	58 min	Vega-1, 20 min	Venera-13, 127 min
Moon	28	3.1 days	Luna-21, 0.11 days	Chang'e-3, 2,460 days
Mars	9	94 days	Mars-3, 0.001 days	Viking 1, 2,313 days
Ryugu	3	414 days	MASCOT, 0.71 days	MINERVA-II1 rovers, 414 days
Titan	1	3.5 hours (end uncertain)	Huygens	
Comet 67P	1	239 days	Philae	
Eros	1	16.2 days	NEAR Shoemaker	
Itokawa	1	55 min	Hayabusa	

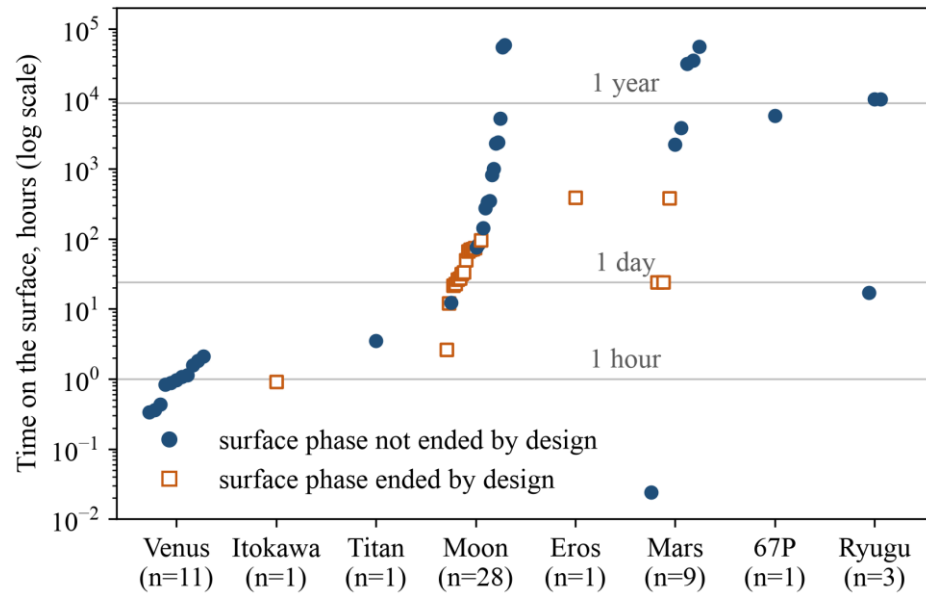


Figure 1 - Surface time of each of the 55 landers by target body, in hours on a logarithmic scale. Filled circles: surface phase not ended by design; open squares: surface phase ended by design

Among the three bodies with nine or more landers, surface times differ strongly (Kruskal-Wallis $H = 22.7$, $p = 1.2 \times 10^{-5}$ for Venus, the Moon and Mars; $H = 16.9$, $p = 2.2 \times 10^{-4}$ when only landers whose surface phase was not ended by design are compared). Venus stands apart. All 11 Venus landers, which landed between 1970 and 1985, stopped within 20 to 127 minutes. The longest-lived of them, Venera-13 at 2.1 hours, stopped sooner than every lunar lander whose surface phase was not ended by design (the shortest of these, IM-2 Athena, worked 12.2 hours) and sooner than five of the six such landers on Mars; the exception is Mars-3. The Venus times are not only a measure of heat, however. Data reception from Venera-9 and Venera-10 ended because the orbiters relaying their signals flew out of view, and the cutoff for Venera-11 depended on how long its flyby probe stayed within range [12, pp. 129, 151]. The landers were also designed for short lives: Venera-10 for 30 minutes and Venera-13 for 32 minutes, while Venera-13 worked for 127 minutes at 462 °C and 88.7 atmospheres [12, pp. 129, 156]. The Venus times are therefore partly limited by the relay link and by design. Ryugu and comet 67P have medians above that of Mars, and Eros above that of the Moon, but they rest on one to three landers each, and on Ryugu the two longest records belong to hopping rovers, so no conclusion is drawn from them.

Three apparent effects. Table 2 shows how the three comparisons named in the question change when the target body is held fixed.

Table 2 - Three apparent effects in the full table and after the target body is held fixed

Comparison (median surface time)	All 55 landers	Without Venus (44)	Moon only (28)
1980s against 1960s	0.66 h (n=4) vs 336 h (n=9)	no landings in the 1980s	no landings in the 1980s

Landings coded LP (parachute assisted) against thrusters	0.92 h (n=12) vs 120 h (n=32)	1.8 h (n=2) vs 120 h (n=32)	no landings coded LP
USSR against USA	1.8 h (n=19) vs 336 h (n=23), 184 times	26 h (n=9) vs 343 h (n=22), 13 times	27 h (n=8) vs 110 h (n=14), 4 times

The apparent collapse of the 1980s comes entirely from Venus: all four landings of that decade were the Soviet Venera-13, Venera-14, Vega-1 and Vega-2 landers. The parachute effect is also mostly a Venus effect: 10 of the 12 landings coded LP (parachute assisted) were on Venus, and the only two elsewhere were Mars-3 and Huygens on Titan. It cannot be tested properly within a single body: no lunar lander used a parachute, no Venus lander used thrusters, and on Mars only Mars-3 is coded LP. On Venus itself, the one lander that used no parachute at all, the Day Probe [11], worked 67.7 minutes, while the ten landers coded LP had a median of 55 minutes and a range of 20 to 127 minutes. The country gap shrinks most clearly. Ten of the 19 Soviet landers went to Venus against one of the 23 American landers; when Venus is removed the gap falls from 184 times to 13 times, and on the Moon alone to about 4 times.

Mission role. Nineteen of the 55 landers had a surface phase that was ended by design: 12 carried an ascent vehicle (the descent stages of Apollo 11, 12, 14, 15, 16 and 17, the Soviet sample-return landers Luna-16, -20, -23 and -24, and the Chinese Chang'e-5 and Chang'e-6 landers), 5 were rover-delivery platforms (Luna-17, Luna-21, the platforms of the Spirit and Opportunity rovers and the Tianwen-1 lander), 1 was an orbiter that descended at the end of its mission (NEAR Shoemaker on Eros) and 1 was the Hayabusa sampling touchdown on Itokawa. Fourteen of these 19 were on the Moon, which is half of all lunar landers.

On the Moon the role explains most of the short records (Figure 2). The 14 landers whose surface phase was ended by design had a median surface time of 1.4 days (range 0.11-4.0 days), against 24.6 days (range 0.51-2,460 days) for the 14 landers whose surface phase was not (exact Mann-Whitney $U = 14$, $p = 2.5 \times 10^{-5}$). Thirteen of the 14 shortest lunar surface times belong to landers coded as ended by design (12 that ended as planned and the damaged sample-return lander Luna-23); the only exception is IM-2 Athena of 2025, which the catalogue describes as "Lander, toppled". All ten lunar landings of the 1970s were crewed, sample-return or rover-delivery missions whose stays were planned to be short; nine ended as planned, and the tenth, Luna-23, was a sample-return lander damaged on touchdown [12, pp. 123-124]. The apparent drop in lunar surface time from the 1960s to the 1970s (from a median of 336 hours to 31 hours) can be explained by what the landers of that decade were sent to do; with no 1970s lunar lander meant to stay long, the catalogue cannot compare their technology.

The same task kept every lander to a stay of a few days at most, whatever its country and decade. The time until the ascent stage left, taken from the catalogue's rows for the ascent vehicles, was 0.90-3.1 days for the six Apollo landers (1969-1972), 0.95-1.15 days for the three Soviet sample-return landers whose ascent stages launched (1970-1976) and 2.0-2.05 days for Chang'e-5 and Chang'e-6 (2020-2024), so the Chinese landers waited about twice as long as the Soviet ones. The Chang'e-5 and Chang'e-6 landers themselves kept transmitting after their ascent stages had gone, to 4.0 and 2.1 days, and Luna-23, whose ascent stage could not launch, stayed in contact for 3.0 days.

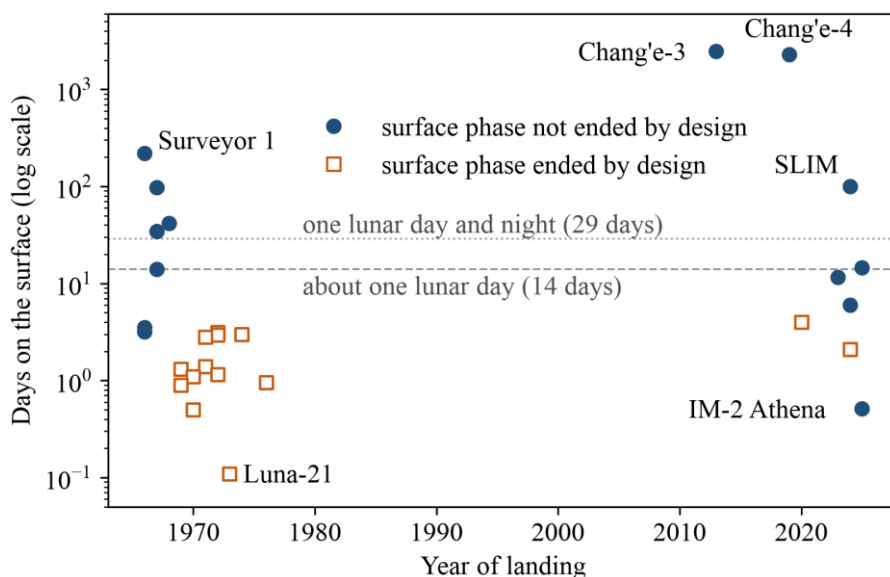


Figure 2 - The 28 lunar landers by year of landing and surface time in days (logarithmic scale).

Filled circles: surface phase not ended by design; open squares: surface phase ended by design. Dashed line: about one lunar day (14 Earth days); dotted line: one lunar day and night (29 Earth days)

The lunar night. The 14 lunar landers whose surface phase was not ended by design split into two groups of seven with a wide gap between them (Table 3). Seven stopped within about 15 days, after 0.5 to 14.6 days. The other seven worked for 34.6 days or more, which means they were still working, or worked again, after at least one lunar night. Both groups include landers from the 1960s and from the 2020s and from more than one country, so neither the decade nor the country separates them.

Table 3 - The 14 lunar landers whose surface phase was not ended by design, from longest to shortest surface time; the first seven worked past at least one lunar night

Lander	Country	Year	Days
Chang'e-3	China	2013	2,460
Chang'e-4	China	2019	2,278 (still listed as operating)
Surveyor 1	USA	1966	219
SLIM	Japan	2024	100
Surveyor 5	USA	1967	97
Surveyor 7	USA	1968	42.0
Surveyor 6	USA	1967	34.6
Blue Ghost	USA	2025	14.6
Surveyor 3	USA	1967	14.0
Chandrayaan-3 Vikram	India	2023	11.6
IM-1	USA	2024	6.0
Luna-13	USSR	1966	3.5
Luna-9	USSR	1966	3.2
IM-2 Athena	USA	2025	0.5

Only two lunar landers worked for more than one year, Chang'e-3 and Chang'e-4. The Chang'e-3 lander's mission lifetime was one year [12, p. 292], and science data acquisition was planned to "continue for 12 months during the nominal mission" [14, p. 85]; the catalogue records 2,460 days, about 6.7 years. A difference between countries does remain among the lunar landers whose surface phase was not ended by design: the two Soviet landers, Luna-9 and Luna-13 of 1966, worked 3.2 and 3.5 days (median 80 hours), while the eight American ones had a median of 590 hours, about 7.4 times longer, and the five American Surveyors of 1966-1968 alone had a median of 42 days. If the damaged Luna-23 is counted with the Soviet landers, their median is 76 hours and the gap 7.7 times. With two or three Soviet landers this difference cannot be explained from the catalogue, which has no information about power sources or design lifetimes.

Mars and the judgement cases. The six Mars landers whose surface phase was not ended by design had a median surface time of 738 days. The longest-lived of them, Viking 1, and the third, Viking 2, both had nuclear power [4]; InSight (1,480 days) was solar-powered [3]. If the Pathfinder lander is also counted as a rover-delivery platform, the median of the remaining five is 1,316 days; if the Tianwen-1 lander is counted as not ended by design, the median of seven is 160 days. If every lander that carried a rover is removed from the landers whose surface phase was not ended by design, the medians become 0.96 hours for Venus (11 landers), 14.6 days for the Moon (9) and 1,398 days for Mars (4), and the Kruskal-Wallis comparison gives $H = 19.2$, $p = 6.6 \times 10^{-5}$. If Luna-23 is instead counted as not ended by design, the lunar comparison becomes 1.3 against 14.6 days ($U = 15$, $p = 3.6 \times 10^{-5}$) and 12 of the 14 shortest lunar times remain in the group ended by design. Mars stays far above the Moon and Venus under every coding. Among the 55 landers, the longest recorded surface time is on the Moon: Chang'e-3 with 2,460 days, whose end date is approximate, unless Chang'e-4, still listed as operating, has passed it. Three of the five longest recorded surface times among the 55 landers are on Mars: Viking 1 with 2,313 days, InSight with 1,480 days and Viking 2 with 1,316 days.

The author's expectations. On 8 October 2026 the author wrote down his expectations: landers live longest on Mars, where InSight worked about four years and Viking 1 about six years, because conditions there are relatively mild, and shortest on Venus, because of extreme heat, a pressure of about 90 atmospheres, sulphuric-acid clouds and strong winds. As the reasons the two Mars landers stopped, he named dust covering the solar panels of InSight and a human error in the case of Viking 1. These expectations were not a blind forecast: by then the author had seen the medians by body (on 3 September) and the full table of landers (on 16 September), and on 19 September he had himself listed Chang'e-3 as the longest-lived lunar lander. Table 4 compares the expectations with the results.

Table 4 - The author's expectations (written 8 October 2026, after he had seen the medians by body and the full table) compared with the results

Expectation	Result	Verdict
Venus has the shortest surface lifetimes	All 11 Venus landers stopped within 20-127 minutes; lowest median of all bodies with more than one lander	Agrees
Landers live longest on Mars	Highest median of the three bodies with nine or more landers (94 days); three of the	Agrees for a typical lander

	five longest recorded times among the 55 landers	
The longest-lived lander is on Mars	The longest recorded time is on the Moon (Chang'e-3, 2,460 days, approximate end date; Chang'e-4 still listed as operating)	Does not agree
Causes: dust and human error on Mars, heat and pressure on Venus	The catalogue does not record why landers stopped	Cannot be tested with these data

Discussion

The author's expectations agreed with the results for Venus, where all 11 landers worked only from 20 minutes (Vega-1) to 127 minutes (Venera-13), a range consistent with the extreme temperature and pressure described by Landis [1], although part of it reflects short design lives and relay links. They also agreed that Mars leads among the large bodies: three of the five longest recorded surface times among the 55 landers are on Mars, which the author attributed to relatively mild conditions; dust settling on solar panels does limit solar-powered landers there [2]. But the longest recorded surface time is on the Moon, not on Mars. Why does the Moon hold that record if the median lunar lander works only about three days?

The answer has two parts. First, the three-day median mostly measures landers that were never meant to stay: Apollo descent stages and sample-return landers whose ascent stages took off, and the two Luna platforms that only delivered the Lunokhod rovers. Second, among lunar landers whose surface phase was not ended by design, those that stopped within about 15 days and those that worked a month or more are separated by a gap: no lander's last signal falls between 14.6 and 34.6 days, the span that contains the first lunar night, which lasts about 14 Earth days [20] and brings surface temperatures down to about -173°C [19]. Chang'e-4 was designed to survive many lunar days and nights: it carries a radioisotope thermoelectric generator for power and three radioisotope heater units [15], it switches to a dormant mode each lunar night because there is no solar power, and it wakes up automatically when the Sun rises high enough [20]. The Chang'e-3 lander had refoldable solar panels and a radioisotope heater unit [12, p. 292]; it entered hibernation before its first lunar night and was brought out of sleep for its second lunar day [12, p. 293], and it is recorded as working for about 6.7 years against a planned one year. By contrast, the Indian Chandrayaan-3 lander was designed for a mission life of one lunar day, about 14 Earth days [16], and the catalogue records 11.6 days. SLIM, which worked for 100 days, survived three lunar nights although that was not part of its original mission plan [17].

On 21 September the author explained the gap between the short-lived Soviet and the long-lived Chinese lunar landers by the different technological level and the different tasks of two eras: the Soviet Union was racing the United States, so its lunar platforms were built as quick transport to unload a rover or collect soil, while China now studies the Moon over the long term. The data support the part about tasks. When China flew the same task as the Soviet Union, returning soil to Earth, its landers also stayed only a few days before the ascent stage left (2.0-2.05 days, against 0.95-1.15 days for the three Soviet landers whose ascent stages launched). The part about eras needs care: American Surveyors of 1966-1968 also worked past lunar nights, so long life on the Moon is not only a feature of recent decades. The idea that the space race pushed Soviet designers towards quick missions cannot be tested with this catalogue.

Taken together, the results suggest an order in which the four candidate factors are associated with surface time. The target body is associated with the largest differences, from minutes on Venus to months or years on Mars. On the Moon, what the lander was sent to do and whether it outlasted the lunar night separate short from long surface times. The apparent effects of decade, landing method and country in the full table largely reflect which bodies and which tasks each programme chose. This order describes 55 landers; it is not a proven chain of cause and effect, and because most bodies have only a few landers it rests mainly on the Moon, Venus and Mars.

Limitations. The catalogue does not record why a lander stopped, its power source or its design lifetime, so the causes named in the Introduction come from the individual sources and not from the data. Surface time is measured until the last signal the catalogue records, which can mean a failure, a planned departure, the end of funding or a lost radio link, as on Venus. The catalogue does not state whether its times refer to the spacecraft or to reception on Earth, which matters only if its two dates for a lander refer to different clocks, as for Rosetta [10], the one case checked; for Venera-10 the times were announced only for the reception of the landing signal on Earth [12, p. 129]. The signal travel time from Titan on the day Huygens landed was 67 minutes [22], which is not small next to its surface time, while for the Moon and for the long-lived Mars landers it is negligible. The value for Chang'e-4 is a lower limit, the end of Huygens is uncertain, and seven end dates are approximate. Fifteen landers carried rovers; twelve had to be judged one by one; the sensitivity checks above show that the main pattern does not depend on these judgements. Cargo objects are excluded, although some of them worked on the surface far longer than any lander in the sample: the catalogue lists the Opportunity rover on Mars with 5,249 days, the Curiosity rover with at least 4,619 days and still active, and the Apollo 12 experiment package with 2,872 days. Finally, most bodies have one to three landers, and comparisons inside them are not possible.

Conclusion

Among the 55 landers in the GCAT lander catalogue that kept working on the surface of another body, surface time is most strongly associated with the target body: all 11 Venus landers stopped within 127 minutes, the median lunar lander worked about three days and the median Mars lander 94 days. The apparent effects of the 1980s, of landings coded LP (parachute assisted) and of Soviet origin largely reflect the Venus landings, which account for all four landings of the 1980s, 10 of the 12 landings coded LP and 10 of the 19 Soviet landers. On the Moon, 13 of the 14 shortest surface times belong to landers coded as ended by design (12 that ended as planned and the damaged sample-return lander Luna-23), and every lander whose ascent stage left stayed a few days at most, whether it was American, Soviet or Chinese. Among lunar landers whose surface phase was not ended by design, those that stopped within about 15 days and those that worked a month or more are separated by a gap: no lander's last signal falls between 14.6 and 34.6 days, the span that contains the first lunar night; only Chang'e-3 and Chang'e-4 lasted for years. When surface lifetimes of different missions are compared, the target body and the purpose of each lander should be stated alongside its country and decade.

Data availability. The GCAT lander catalogue is publicly available at the address given in reference [7]. The coded table of the 55 landers and the analysis scripts are kept by the author's research mentor and are available on request.

Author contributions and use of AI tools. The author chose the research direction and, between 3 and 16 September 2026, the research question, each from a menu of options prepared by his mentor; the first option of the question menu already stated the expected answer. His

contributions in the chat are: a list of the three longest- and three shortest-lived lunar landers in the working table, with the observation that Luna-17 and Luna-21 only carried rovers (19 September), which led to the coding of mission roles; an explanation of the difference between Soviet and Chinese lunar landers (21 September); a table, sent as a screenshot, of the three Mars landers whose catalogue comment says they delivered a rover (26 September); a list of five sources on individual missions with one-line summaries (30 September); his expectations about which body has the longest and the shortest surface times (8 October); and a paragraph comparing these expectations with the results (9 October). He made the 19 September list, the 26 September table and the 30 September source list with the help of Gemini (Google). His texts, all in Russian, were translated, shortened and edited for the paper. In the 9 October paragraph the author explained the long-lived lunar lander by the Apollo surface experiment packages, which are not among the 55 landers; that part was replaced by the explanation of the Chang'e landers in the Discussion, which the mentor wrote from sources [12], [15], [16], [17], [19] and [20]. Of the five sources the author listed, only the Huygens paper [5] was given with an identifier that leads to the cited work; the mentor corrected the identifier of the ALSEP report [6] and replaced the other three with sources [1], [2] and [4], which he could open and check. His research mentor (Sydyk Assyltay) downloaded the catalogue, built and translated the working table, coded the mission roles, ran all computations, produced the figures, found the remaining sources and wrote the Introduction, Materials and Methods, Results, Discussion and Conclusion in English, using an AI assistant for the code, the computations, the translation and the drafting. No number in the paper was produced by a language model: every result comes from the analysis scripts applied to the published catalogue, and every other number is taken from the source cited next to it.

Acknowledgements. Data from GCAT (J. McDowell, planet4589.org/space/gcat).

Conflict of interest. The author declares no conflict of interest.

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