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A CASE STUDY FOR DEVELOPING A LUNAR RESEARCH OUTPOST FUNDED BY COMMERCIAL SCIENCE OPERATIONS.

Abstract

Purpose: The Artemis Missions, Moon Village concept, and the International Lunar Research Station will initially be government-led, but transitioning to commercial partnerships will accelerate technological advancements. [1][2][3] The Base for Lunar Assessment, Science, Testing, Exploration, and Research (BLASTER) aims to establish a viable business model for an in-situ Lunar proving ground, supporting scientific missions and mitigating risks associated with Lunar operations.

Methodology: This plan assumes that foundational Lunar exploration is complete, with a sustained human presence. [4] Key assumptions include:

1. Availability of power, communications, refueling, Positioning, Navigation, and Timing (PNT) services, and Lunar launch/landing for commercial use.

2. A minimum of four rotating crew members permanently stationed on the Lunar sur-face.

3.Continuous robotic exploration on the Moon.

BLASTER proposes a crewed Lunar base providing four essential services to expedite Lunar technology development:

1.Experimental pod space with standardized compartments and adjustable environmental conditions.

2.Astronaut-facilitated experimentation with-in these pods.

3.Exterior Lunar proving grounds with pre-defined terrain features for testing.

4.Maintenance and intervention capabilities for rovers and experiments.

As operations scale, additional environmental conditions and expanded testing capabilities may be incorporated. A trade study assesses the sensitivity of this business model to market conditions.

Results: The estimated cost of transporting materials to the Moon ranges from $1M per kg at present to $10K per kg with future heavy-lift rockets. [5] Assuming $100K per kg, the initial capital expenditure for an independent habitat and testing facility would be approximately $5B, with annual operating costs around $500M, depending on utility pricing.

Conclusion: Economic viability depends on minimizing launch and infrastructure costs, with precise cost thresholds requiring further analysis. The World Economic Forum projects a $100B space industry market by 2035; achieving just 1% market share could render this venture profitable. [6]

References: [1] Artemis Accords (2020), https://www.nasa.gov/artemis-accords/ [2] N. Labeaga-Martinez, et al. (2017) Procedia Manufacturing, MESIC 2017: 794–801 [3] International Lunar Research Station Guide for partnership (2021) [4] NASA's Moon to Mars Architecture, Revision B. NASA, 2024, pp. 118–119. Accessed: Feb. 27, 2025. [Online]. [5] "SpaceX 10-Year Lunar Architecture Capability Study (LunA-10) Lunar Surface Innovation Con-sortium (LSIC) Spring Meeting," 2024. [6] A. Acket-Goemaere, R. F. Ambrose, N. Khyl-stov, R. Brukardt, J. Klempner, A. Sierra, and B. Stokes, "Space: The $1.8 Trillion Opportunity for Global Economic Growth," *World Economic Fo−rum, Geneva, Switzerland*, 2024.