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Space Resources, the Enabler of the Earth-Moon Ecosphere (5)

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ANALYSIS OF TECHNOLOGY, ECONOMIC AND LEGISLATION READINESS LEVELS OF
ASTEROID MINING INDUSTRY : A BASE FOR THE FUTURE SPACE RESOURCE UTILIZATION
MISSIONS

Abstract

Since the first space observers in 1845 recognized the countless benefits asteroid mining holds for humanity, although not economically viable yet, technological advancements have made the aim to exploit mineral and metallic resources from celestial bodies such as Moon, Mars and Near Earth Objects (NEOs) like asteroids more feasible. The ongoing missions such as Lucy, Psyche 16, Hayabusa-2 and OSIRIS-REx developed by students, scientists, space agencies and private companies, continue to improve the technology and cost readiness levels of the space mining industry. This paper contextualizes the advances, prospects for the development of asteroid mining activities by building on the success of previous space resource exploration missions and predicting the future of resource utilization in development of space habitats.

More than just providing a state-of-the-art, this paper highlights the importance of sustainable investments in asteroid mining projects, the strategies in vogue and identifies the mission feasibility factors.

First, an analysis of space resource exploration missions and the type of asteroids catalogued by space agencies, International Asteroid Warning Network and United Nations Office for Outer Space Affairs is provided. Second, the key factors influencing legal, ethical, economic logistics and technological advancements of asteroid mining missions are presented. This also includes techno-economic analysis of key technological factors such as accurate trajectory calculation and prediction, maneuvering capabilities, where simple performance improvements would bring asteroid and Moon mining projects nearer to their economic attainability. Finally, the impact of cost, technology readiness levels and mission feasibility on recent unmanned space resource missions is presented, providing recommendations to bridge the existing gaps for mission execution and implementation levels.

The growing threats of an asteroid impact coupled with rapid depletion of natural resources on Earth, make asteroid mining an increasingly urgent subject. Since the existing state of technology does not meet appropriate standards, current, past successful techniques and potential alternatives have been identified

and listed to gain maturity for asteroid mining missions. Based on existing literature, specific logistic aspects such as bridging the gaps in terms of legislation, in-orbit construction and servicing using the mined resources is presented. This paper aims to support the International Asteroid Warning Network, Impact Disaster Planning Advisory Group, Space Mission Planning Advisory Group, Space agencies, educational institutions and interested stakeholders by providing a critical analysis of state of the art for optimal future development of the space mining industry.