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## INNOVATING IN COMPLEX SYSTEMS: ASSESSMENT OF PROPOSED IN-SITU RESOURCE UTILISATION (ISRU) MISSION SYSTEMS AND EXPLORATION STRATEGY DEVELOPMENT

**Abstract**

In 2019, ESA published its first iteration of the Space Resources Strategy by establishing space resources as a boon for economic growth. The framework is aimed to incentivize Europe's participation. This takes into consideration an innovation-led approach where benefits are leveraged to bolster Europe's capability and competitiveness on a global stage. To foster industry engagement, a mission-oriented framework is applied to the strategy by establishing a vision: "Human presence at the Moon, sustained by local resources, by 2040". To achieve the overarching objectives described in the strategy, In-Situ Resource Utilisation (ISRU) and its challenges are highlighted as a springboard to untapped opportunities and to strengthen international partnerships.

A significant constraint to current lunar exploration efforts is the rising complexity that is ineffectively tied with traditional organisational theory and practice. This is driven by inadequate management of technical and programmatic risks in complex systems.

The objective of this research paper is to showcase an ISRU tradespace exploration that reconciles the Space Resources Strategy vision. An integrative approach is used to bridge analogous terrestrial applications and new developments in technology roadmapping for space systems. This combines exploration and utilisation of space resources to enable sustained human presence on the surface of the Moon. Key outcomes are extracted in the form of incentivized investments and change drivers with promising potential for implementation. The scope is therefore cross-sectoral and limited to ISRU challenges and resource scarcity trends on Earth. Furthermore, behavioural dynamics and a sensemaking model are applied with the application of the Cynefin framework to map context-driven challenges. To ensure that tangible results are drawn, ISRU architecture from the International Space Exploration Coordination Group is used for benchmarking.