Scientific Journal of Space Management and Space Economy
Cilt: 1 | Sayı: 1 | Aralık 2022
Volume: 1 | Issue: 1 | December 2022

SPACE COLONIZATION AND EXPLORATION; AN ECONOMIC EXERCISE

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Makale İlk Gönderim Tarihi / Recieved (First): 21.12.2021 **Makale Kabul Tarihi / Accepted:** 30.06.2022

Atıf/©: Tiwari, S., (2022). Space Colonization and Exploration; An Economic Exercise. Scientific Journal of Space Management and Space Economy, 1(1), 53-62.

Abstract

This article reviews how the status of the term "Economy" has changed among various states, leading them to make a sustainable society on Earth and Outer Space. Though with the current budget and innovations, the idea of space settlement still seems far-fledged. However, with international collaboration, some results predicted humans would flag Mars in the near future. With the increased funding on science and technology and international collaboration, some states are on the verge of constructing new pathways to another world. Such investment will help humans be an interplanetary species and develop new values and methods to their knowledge. This article also discusses some of the settlement models that might be possible in the near future, provided the investment feasibility.

Keywords: Space settlement, economics, interplanetary habitat, science exploration, human settlement

Jel Codes: O23, O32, B15, L93

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Introduction

The Economy has played a significant role in stabilizing the era of Mankind, so let it be their expanding the sustainable colonization by examining the social-environment development (Polasky et al., 2019), or dodging a model for equal privileges. Today, new breakthroughs are being co-operated by private space agencies which were once thought to be speculative so let it be development of reusable rockets or the visions of space travel (Yazıcı & Tiwari, 2021). Now it is these private corporations like SpaceX are partnering with the state agencies with an ambition of delivering humans to Mars. With its business model, humanity is looking for its long-term goal of sustaining them over other celestial bodies with a good return on investment. Several of the budget sheets have been created by several space organizations that could ensure human efforts to colonize space. For instance, with the Artemis mission, NASA hopes to pave a path for Mars by building a lunar gateway (NASA's Lunar Exploration Program Overview, 2020). Human settlement programs would help to void the questions against humankind's survival and detect the Big Bang's fingerprints by establishing the telescopes on celestial bodies (Siegel, 2018). i.e., Far Side of the Moon. This article will follow a brief investigation on the human settlement on space and Earth, with the first dedicated to the historical preview for economical configuration that has been developed within the society. The second section concludes the investment approach for settlement and scientific exploration. The last section of the article follows the type of settlement models along with a brief introduction about the Artemis program that would be approached by humans in the immediate-future through an international collaboration.

1. Humans on Earth

Human civilizations have existed for more than 6,000 years on Earth. However, most breakthrough developments have been started in the last three centuries, making humans a dominant species over others. From theories to applications, humans started to work on every core aspect which could enable their sustainability not on Earth but also over other celestial bodies.

1.1. Historical Trends of Economy in Human History

Economics is defined as the science which regulates the production & consumption of goods and services by society. The foundation of the Economics and financial concept was laid down long before, in the bronze age, approximately 4,000-5,000 BCE. It was not until mid of the 18th century when Adam Smith laid down the foundation of modern economics, whose work introduced the concept of Capitalist production, free markets, and values in Economics.

As soon as the definition of economics was concise, nations started to implement its universal characteristics during global industrialization. A study performed on the U.K. historical background suggests that most of the hike in average income per capita occurred only within the last two centuries, with the development of machines and industrializations (Roser, 2013).

Though a few dips in the nation's Economy have been observed due to some unprecedented events like the 2008 economic crisis and the global pandemic of 2019, an overall growth entropy of the global economy is still constructive.

1.2. Expenditure in Settlement on Earth

An estimation reports that about 150 million people worldwide could be considered homeless, with 1.6 billion having "inadequate shelter." Several states like India, Australia, and others have launched their scheme to provide or subsidize permanent shelter to the most vulnerable segment of people, including children, disabled, and mentally -ill people of different age groups (Scheme of Shelters for Urban Homeless, 2013) (G Housing and Homelessness, 2020). With these schemes, the different governments have prepared different budget schemes to make sure settlement of every part of the population on Earth, for example, $3.3Mn by the Australian government (Affordable Housing, 2021), $567 million by the Canadian, and $1.13Mn by the regional government in Germany (Homeelessness in Germany, 2017) to tackle homelessness.

1.3. Approaches to Settlement in Space

As the governments' primary problems regarding settlement are getting sorted, new organizations are now being co-operated to wing human visions of colonizing other extra-terrestrial planets. Several organizations, including government and private, have their plans and timelines to approach settlement in space. Settling in space or over other planets might allow humans to extend their values (Haqq-Misra, 2016) and preserve the human race from any intermediate threat (Globus et al., 2017). Giants like SpaceX have unveiled their plan of colonizing Mars, detailing the number of people required to make a colonial settlement along with the rocket-ship specifications (Chandler Unified School District, 2018). Currently, various ideas are being tested and measured, which could open the gate for humans to settle on space under a minimum budget as possible.

2. Scientific Exploration

A background scientific investigation is always required before approximating the room for human habitability in other corners of the solar system. To undertake such an examination, there is always a need for investment in several scientific instruments like Telescopes, Probes, and other ground-based channels. This section will analyze the budget configuration and models that space-based research institutions plan to launch to serve scientific exploration and human curiosity.

2.1. Investment in Scientific Exploration

NASA has published its' recent budget directory for the Fiscal Year 2022, emphasizing most of its' budget for Science and Research development, approximately $7.91Bn, followed by Deep Exploration System (D.E.S.) with a budget of around $6.88Bn. However, this trend is to grow year by year with $8.6Bn in science and $7.77Bn in D.E.S. by 2026 (NASA, 2021), defining the efforts NASA is dispersing to create a room for human exploration and settlement.

Not just NASA, other state institutions like the Japanese Aerospace Exploration Agency (JAXA), Indian Space Research Organization (I.S.R.O.), and European Space Agency (E.S.A.) are also taking their record for their budget investment in Scientific Exploration and development of space transportation systems.

E.S.A. has prioritized its' budget domain for Space Transportation and Scientific programs as second and third highest with the funding of $1.32Bn and $630Mn correspondingly (E.S.A. Budget 2021, 2021).

2.2. Investment Outcomes

With the current investment plans, this subsection will provide the list of the significant scientific projects declared under their listing.

- James Webb Space Telescope: Acronymed as JWST, the primary task of JWST will be to use optimized Infrared rays to peek over the composition of the extrasolar rocky worlds with improved sensitivity (Scientific Discovery with the James Webb Space Telescope, 2018), and peer back to 13.5 billion years to observe the first light of the universe.

- D.S.E. project: This project involves the missions like Artemis, which would allow the first woman to land over the lunar south pole and the development of the lunar gateway module, to support the successive landings on to the Moon (An Overview of the Volatiles Investigating Polar Exploration Rover (VIPER) Mission, 2019).

- Plankton, Aerosol, Cloud, ocean Ecosystem (PACE): Due by launch in 2023, this mission will have the sole purpose of identifying the duration of Phytoplankton Bloom and understanding the dynamics of Earth's air quality.

- VIPER: Volatile Investigating Polar Exploration Rover or VIPER will be proving its significance by searching for volatile minerals, i.e., water ice (H2O), in lateral and vertical settings at the southern pole of the lunar surface by 2023. VIPER will be the first-ever resource mapping mission to pave a path for sustainable human settlement on another celestial body.

- Jupiter Icy Moon Explorer (JUICE): Due by launch in 2023, this E.S.A. mission will provide humans a better understanding of the formation of Jovian and habitability conditions of its neighboring Moons(Grasset et al., 2013). The JUICE mission will elucidate the possible habitability of the subsurface ocean of Europa, Ganymede, and Callisto.

3. Investment Plan for Space Colonization

The above section describes how the states are disbursing their space exploration budget. However, this section will briefly entail the investment program that is more centric towards human settlement over other celestial bodies.

3.1. Historical Models for Space Colonies

Edward Everett Hale, in 1869, was among the first few visionaries to portray the picture of space colonization. In his work, he described the construction and launch of a brick-made 200 feet wide diameter satellite, inhabited by humans, into the Earths' orbit (Hale, 2017). His fictional description can be co-related with modern-day International Space Station (I.S.S.). Soon after Edward Hale, other visionaries and scientists also shared their fictional models. One of them was Konstantin Tsiolkovsky, a pioneering Russian rocket scientist. In his book, Beyond Planet Earth, published in the early 20th century, Tsiolkovsky depicted space colonizers growing crops for their survival and generating greenhouse gasses. He also forefronted the idea that space colonization would preserve the human species as a whole by minimizing the risk of extinction (A.S.C.L., 1961).

Gerard K. O'Neill published another interesting idea to colonize space in his book in 1977, The High Frontier: Human Colonies in Space, envisioning the human establishment in the stable Lagrangian point of the Earth-Moon system. He also mentioned harnessing the resources of lunar and Near-Earth Asteroids to develop spacecraft in these Lagrangian points, enabled with artificial gravity (O'Neill et al., 2019). Further Ideas continue to be developed proposing low-cost human habitats in space or over the surface of other celestial bodies for more extended sustainable periods.

3.2. Orbital Settlements

Equatorial Low Earth Orbit (E.L.E.O.): An orbital settlement may be built under the 500 Km orbit of the Earth. These accommodations would be the most economical settlement by providing the tourists, materials, and energy exchange service daily compared to the interplanetary settlements. Such structures would also have lower transportation cost. It would allow humans to return to Earth in a matter of hours in case of any tragedy (Globus et al., 2017).

In terms of radiation risk, these settlements would also possess the negligible radiation effect, with relatively lower energy particles, that could easily be coped with the minimal shielding (Globus, 2017) using Earth-based materials. These settlements may use solar power as their primary source of energy to fulfill the standard requirements of travelers. With all the advantages of an Orbital settlement, there is a good reason to believe that early settlements might be carried out in Earths' orbit, followed by successive colonizations over the region of other celestial bodies (National Space Society, 2021).

3.3. Lunar Settlements Model- The Artemis Model

The lunar touch-down in the 21st century with the Artemis program was not an instantaneous act but long planning with the collaborative research institutions. This section will brief the Artemis model and its objective of ensuring the long-term presence of humans on the Moon, unlike the Apollo Mission.

With the tentative combined budget of $93 Bn (Wall, 2021) estimated to be spent for the Artemis program, the program is planned to be conducted into three phases, Artemis -I, Artemis-II, and Artemis-III, with their respective components including S.L.S. (Space Launch System), Orion Spacecraft, Lunar Gateway, Moon landing module. The mission is set to be the first mission with large-scale collaboration with commercial companies like SpaceX, Blue Origin, and Boeing and international partners like E.S.A., Australian Space Agency, and JAXA followed by future space missions which could be the subject of commercial activities for private and state enterprise (Yazıcı & Darıcı, 2019).

- S.L.S.: This super heavy-lift expendable launch system has been under development since 2011 under NASA, intending to carry 180,000Kg under the Artemis Program. An approximation of $800 Mn per launch (Artemis Program: What You Need to Know about NASA's Moon Mission, 2021) for this launcher has been estimated.

- Orion Spacecraft: Equipped with the Life support system, Orion is a command module designed to carry the Artemis astronauts to the Moon. Orion uses some similar configuration as Apollo Command and Service Module (C.S.M.) but with increased complexity and thermal protection system.

- Lunar Gateway: Similar to that of the International Space Station (I.S.S.), the Lunar Gateway will be a small space station revolving around the Moon, designed to serve as a hub for the astronauts in exploring (Artemis Program: What You Need to Know about NASA's Moon Mission, 2021) and constructing settlements on the lunar surface. The first pieces of Lunar Gateway are tentative to be launched by 2022.

- Moon landing Module: The landing module would serve in back and forth landing of Artemis crew, cargo, and robotics down to the lunar surface from the Lunar Gateway. For the Human Landing System (H.L.S.) design, NASA made a contract with SpaceX, Blue Origin, and Dynetics worth $967 Mn.

The first three Artemis missions will compile sending and testing of the Orion capsule into the orbit of Moon, sending the crew of four Astronauts into the orbit of the Moon, and boarding over the south pole of the lunar surface using the Lunar Gateway, respectively. The Artemis would try to establish the human base for its long-term presence using Technology, Resources, and Partnership. If successful, Artemis would become the foundational mission in its first steps for making humans an interplanetary mission utilizing the Lunar Gateway for possible missions to Mars.

3.4. Martian Settlement Model

The only planet in the solar system that could sustain humans with the progression of current technological models in the near future is Mars. Unlike the Moon, being at a distance of 361 million Km from Earth, it might take approximately six months for the first crew to be transported onto Mars when it is closest to Earth. Elon Musk, the C.E.O. of SpaceX, has a vision of starting human self- settlement

on Mars as early as 2050. Musk has estimated a budget of approximately $100 Bn to $10 Tn to establish the first city on Mars (Brown, 2019).

Sustaining a city on Mars would be more challenging than maintaining it on Earth. Unlike Earth, the Martian atmosphere consists of 95.32% of carbon dioxide, 2.7% of nitrogen, 1.6% of argon, and trace levels of carbon monoxide. Humans would need advanced tools to perform In-Situ Resource Utilization (I.S.R.U.) to extract Oxygen (O2), H2O (water), and other necessary elements out of the Martian surface to accommodate a certain martian population (Tiwari, 2021). However, to cop-out the harsh Martian environment, some designs of the future Martian inhabitants have been suggested, including Mars Pyramid and Mars Acropolis (Williams, 2021). Such settlement programs would help humans explore the new spectrum of values and evolutionary destiny (Colonizing Mars Could Speed up Human Evolution, 2021). The ambition of human settlement over the other celestial bodies can only be bridged with feasible funding and progression in technology. However, an in-depth investigation is required of the critical funding needs, which is not under the scope of this article.

Discussion

This article has briefed how humans have evolved the concepts of economics to run the individual states. With humans more accessible with their budgets, now they are endeavoring for the settlement program in space. The new budget focuses not only on the settlement programs but also on the deployment of scientific instruments, which would eventually aid the knowledge of humans about our universe and the values that first settlers might perceive during their inhibition over other celestial bodies Taking the historical model and regulated budget sheets as an example, humans are now attempting to establish their colony with the Moon as a primitive point that would eventually open the doors for inhabiting other celestial objects. For space settlement, it is suggested that orbital settlements would be far more economical and easily accessible than a planetary settlement, i.e. Mars, due to a number of factors like Resource availability, proximity from Earth, and the radiation effects.

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