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DECENTRALIZING THE FINAL FRONTIER: EXPLORING BLOCKCHAIN APPLICATIONS IN OUTER SPACE

~ Snigdha Mukherjee

Having found applications in various terrestrial domains such as healthcare, cybersecurity, IoT, and supply chains, Blockchain technology, recently, has sparked conversations about growing interest in exploring its potential benefits for outer space activities. Key players in the space industry, including both public agencies like NASA and ESA and private companies, are considering the integration of blockchain into their operations. For instance, NASA and ESA are considering exploration in blockchain's utility in mission design and the governance of satellite constellations for further development. Additionally, it is foreshadowed[1] that upcoming space missions plan to deploy blockchain nodes in orbit and on the Moon. The use of blockchain is also being contemplated for enhancing space sustainability efforts, including space debris mitigation and data/service marketplaces for Earth Observation applications.

However, while humanity aims for lunar colonization, the issues of a lack of sovereign jurisdiction are bound to arise in the near future.This article seeks to navigate through the realities of the current and future usage of Blockchain technology and whether it can facilitate, 'Moon NewSpace." which looks into establishing equity between the public and private sector while being cognizant of international space law.

[1] R. Zhang, W.K. (Victor) Chan, Evaluation of Energy Consumption in Block-Chains with Proof of Work and Proof of Stake, J. Phys. Conf. Ser. 1584 (2020) 012023. https://doi.org/10.1088/1742- 6596/1584/1/012023.

Blockchain's technical prowess[2] is deemed to be catching the attention of the Outer Space Industry, for example, the ESA, that is, the European SpaceAgency is bound to use blockchain technology for better service and date saving while ensuring that annual budgets are met.the usage of blockchain is also being considered for space traffic management while ensuring that stakeholders are provided with utmost factual transparency. There is also talk about crypto currency being used for taking over space based assets like satellites[3] and celestial bodies while facilitating the long awaited beginning of space mining. The advent of blockchain technology has also caught the eye of SpaceChain that is working on an approach that aims at storing cryptocurrency in space. The sudden light that is being thrown upon the possible advantages of the rise of blockchain technology in Outer Space is one that is bound to create revolutionary precedents in the technology industry, especially that of Outer Space.

The revolutionary coming together of Blockchain and Cryptocurrency with the outer space industry is to cause an immense shift in the ideas of limit in various technological fields, constantly reshaping its traditional boundaries.

Blockchain, coupled with Artificial Intelligence and the Internet of Things is known to form the holy trinity of disruptive technology. With its roots in Fintech, Blockchain brought about the concept of Bitcoin which with its drop completely revolutionized the arena of digital ownership. With having grapled in various sectors, it is only natural for Blockchain technology[4] to enter the Outer Space sector.

The Moon Agreement[5] 1979 focuses on how countries can explore and use the Moon's resources. One of its main points, "common heritage of mankind", means that the Moon and its resources belong to everyone on Earth, and countries should share the benefits of using them equally. This

[2] C. Schinckus, The good, the bad and the ugly: An overview of the sustainability of blockchain technology, Energy Res. Soc. Sci. 69 (2020) 101614. https://doi.org/10.1016/j.erss.2020.101614.
[3] European Commission, COM(2020) 593 final. Proposal of the European Commission for a Regulation of the European Parliament and of the Council on Markets in Crypto-assets, and amending Directive (EU) 2019/1937 (MiCA Regulation), (2020). https://eurlex.europa.eu/resource.html?uri=cellar:f69f89bbfe54-11ea-b44f
[4] C.M. Christopher, The Bridging Model: Exploring the Roles of Trust and Enforcement in Banking, Bitcoin, and the Blockchain, Nev. Law J. 17 (2016) 139.
[5]I. Bratu, A.R. Lodder, T. van der Linden, Autonomous space objects and International Space Law: Navigating the Liability Gap, Indones. J. Int. Law. 18 (2021) 423–446. http://dx.doi.org/10.17304/ijil.vol18.3.818.

has sparked heated debates because some think it might bolster anti competition and lack of business. However, many countries like the USA, the UAE, Japan and Luxembourg haven't signed this agreement, hence there's no clear rule enacted against using the Moon's resources. Some countries, like the United States and Luxembourg,[6] have made their own laws allowing companies to use these resources as long as they don't claim ownership of the Moon itself.

The Artemis Accords[7], started by the United States in 2022, also say that using space resources won't mean owning them like a country would. Instead, it follows the rules of the Outer Space Treaty.

The difference between a country claiming ownership of a celestial body and companies using resources from it is talked about where it is propounded that the market should decide who gets these resources, with the government only playing a small role.

In this debate between government and market, blockchain technology might help create a new way of managing this process, with its main role in decentralization.

Blockchain technology is maintained and developed in the Outer Space community, the main issue faced by private actors in the outer space industry by revolutionizing space and currency based activities around the moon. With appropriate guidelines[8], there will be a need for Blockchaun technology to overcome ever present hurdles with major challenges primarily with regard to sovereignty and sustainability.

Unlike otters, blockchain’s decentralized nature is optimal for secure transactions as each transaction is recorded on a distributed ledger on a network of notes, increasing its reliability and evading privacy and security concerns.

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[6] P.D. Filippi, A. Leiter, Blockchain in Outer Space, Am. J. Int. Law. 115 (2021) 413–418. https://doi.org/10.1017/aju.2021.63.

[7] NASA, Artemis Accords, (2020). https://www.nasa.gov/specials/artemisaccords/img/Artemis-Accords-signed13Oct2020.pdf (accessed August 2, 2022).

[8] ESPI Yearbook 2019: Space Policies, Issues and Trends, European Space Policy Institute, n.d. https://espi.or.at/?view=article&id=468:espiyearbook-2019&catid=29.

The amount of transparency that blockchain technology provides along with its real time data accessibility, allows it to have a better standing in the Outer Space industry[9] as compared to Government based ventures due to their centralized nature. This centralization[10] of the government is the result of its downfall considering their data saving downtime which has often resulted in loss of data in the long run as well. The same applies to Smart Contracts, a feature unique to blockchain technology that speeds up transaction time and process due to the lack of a centralized intermediary like that of the government.this enables said technology to be one step above the traditional contract making process.

The main advantage that Blockchain technology offers is its decentralized nature, which allows anyone with a stable internet connection and blockchain enabled currency to make transactions that are inherently autonomous. This increases accountability[11] while also not sacrificing autonomy hence creating space fo democratic decisions and plans in Moon based activities.

Blockchain's detachment from bodies of authority, that is, government bodies allows individuals to make transactions autonomously, this holds up the principles of NewSpace that throw light on the need for alternative governing models/bodies for appropriate financial action.

Yet, this autonomy and lack of regulatory framework is what has caused issues of crypto-crime and rampant exploitation of available data. In order to fully enable the power of blockchain technology, a fixed regulatory framework is vital.

Despite the self-sufficient nature of smart contracts within digital environments, enforcing contractual agreements in real-world scenarios poses various challenges. Disputes that occur beyond the blockchain world[12], require the involvement of third party players which can various issues, all that are high risk. This calls into question the need and validity of the Blockchain system.

[9] H. Hassani, X. Huang, E. Silva, Banking with blockchain-ed big data, J. Manag. Anal. 5 (2018) 256–275.
[10] SpaceChain, Spacechain.Com. (n.d.). https://spacechain.com/ (accessed September 3, 2022).
[11] Y. Mezquita, D. Valdeolmillos, A. GonzálezBriones, J. Prieto, J.M. Corchado, Legal Aspects and Emerging Risks in the Use of Smart Contracts Based on Blockchain, in: L. Uden, I.-H. Ting, J.M. Corchado (Eds.), Knowl. Manag. Organ., Springer International Publishing, Cham, 2019: pp. 525–535. https://doi.org/10.1007/978-3-030-21451-7_45.
[12] J. Shah, S. Parveen, Understanding the Blockchain Technology Beyond Bitcoin, in: R.K. Phanden, K. Mathiyazhagan, R. Kumar, J. Paulo Davim (Eds.), Adv. Ind. Prod. Eng., Springer, Singapore, 2021: pp. 499–516. https://doi.org/10.1007/978-981-33-4320- 7_45.

Apparent concerns regarding the concentration of control over blockchain networks have emerged, highlighting the high potential for manipulation and exploitation by a certain subset of participants. Safeguarding against centralized control requires regulatory interventions[13] to ensure equitable access and participation, thereby preserving the democratic ethos[14] of blockchain technology.

Blockchain technology, specifically mining activities use extensive energy which does not absolutely comply with sustainability standards[15] while also relying on fossil fuels in most regions. This raises concerns for switching to more sustainable and long term mechanisms which meet the characteristics of the same Blockchain Technology mechanisms.

While Blockchain technology offers a multitude of advantages for Outer Space activities[16], issues of crypt crimes, sustainability and system manipulation are concerns that need to considered as soon as possible. Only with these changes and a fit regulatory framework,[17] can blockchain technology make an impact in harnessing the power of Outer Space exploration.

[13] NASA STTR 2020 I Solicitation | T11.03-6321 - SCRAMBL (Space Communication Reconstruction and Mapping with Blockchain Ledgering) | Proposal Summary, Nasa.Gov. (n.d.). https://sbir.nasa.gov/SBIR/abstracts/20/sttr/phase1/ STTR-20-1-T11.03-6321.html (accessed September 3, 2022).
[14] Minerva's plan to revolutionize space domain awareness with NFTs, SpaceNews. (2021). https://spacenews.com/minervas-plan-torevolutionize-space-domain-awareness-with-nfts/ (accessed August 21, 2022).
[15]] What's the Environmental Impact of Cryptocurrency?, Investopedia.Com. (n.d.). https://www.investopedia.com/tech/whatsenvironmental-impact-cryptocurrency/ (accessed August 21, 2022).
[16] O.M. Ribbelink, Technological Development and the Development of the Law of Outer Space Papers of the Thirty-Eighth AAA Congress Organized in Co-Operation with the European Council of Environmental Law, Funchal, Madeira, 7-9 November 1997: Technology and International Law, Hague Yearb. Int. Law. 10 (1997) 3–16.
[17] Blockchain, Law and Governance, n.d. https://link.springer.com/book/10.1007/978-3-030- 52722-8 (accessed August 3, 2022).