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Decentralized Virtual Reality

Abstract

Recently, blockchain technology has arrived in new areas and some innovative experiments have been done. That is the case for Virtual Worlds, which since the emergence of the so called “Metaverse” they started to evolve and explore new ways of interacting with other users on the web.

In this project we will mainly focus on Decentraland, one of the most decentralized virtual worlds that offers a virtual environment where users can visit or own worlds and do funny and profitable events such as fashion, art or music shows, galleries for selling/buying NFTs, worlds for exploring and advertising brands and many more. Also, we will compare it with its competitors analyzing the advantages and disadvantages between them.

In addition, we will dive into the development of a world in which virtual users will be capable of doing transactions. The possibilities given by the technology applied in this Metaverse are vast, as said before. This project takes a sip of them, creating a small fortress with some decoration and one *Donation Box.* This box has an address hardcoded, pointing to the wallet to which one can give MANA (the cryptocurrency used in Decentraland).

In conclusion, this project shows the advancements in this area and the features that Decentraland offers in comparison with others as well as the implementation feasibility, the requirements involved and the knowledge needed to create, publish a scene and perform very simple crypto transactions.

1.Introduction

Virtual worlds (VW) are simulated environments where people can create an identity, create a personalized avatar and interact with others for exploring the virtual world and for doing activities together [1]. VW have evolved during the recent years with the use of virtual reality (VR) devices to interact in these 3D simulated worlds. This led to the Metaverse, a fully immersive experience that can be lived in virtual worlds [2].

Moreover, the advancements in blockchain technologies boosted the interest in decentralized virtual worlds (DVW). In comparison with traditional virtual worlds, DVW are not managed by a single organization or entity, instead they are controlled by the network of users[2].

Some examples of DVW are Decentraland, The Sandbox , Somnium Space and Cryptovoxels. Even though they are all somehow decentralized, they have several differences depending on the way their blockchain networks work. In this project we will focus on Decentraland because it is the one we know the most and we found it easier to do the implementation.

2.Contribution

This work explores this new technology, taking into account the history of virtual worlds and how blockchain-based virtual worlds have evolved, doing an analysis of different types of decentralized virtual worlds where we have shown the attributes each of them have in comparison with Decentraland. Also, we have done the implementation of a world, showing the necessary steps for coding a scene, publishing it and then deploying, in this case in Decentraland. This project can be useful for having an understanding of DVW , the options that there are and their blockchain-based features and the learning and feasibility of creating a world in this type of modern virtual world.

We have all gone through the different parts of the work although some of us have focused more on some parts than others. Camila and Xavier have done research through the literature for explaining the works that have been done during these years about this topic. They had also done some trials with the Decentraland project. Dario and Alex have focused on the implementation, coding and more technical concepts about the functionality of Decentraland project structure and they have also collaborated in the elaboration of the report.

3.Related work

Since the creation of the early Virtual Worlds around the 70s, they had been evolving limited by the technology of the moment. The first virtual worlds that were launched on the Internet were text-based chat rooms. It was not until the 90s when some VW were created in a 3D environment [1]. That is the case of Worlds.com, an online 3D chat program started in 1995 that offered prebuilt avatars and worlds that could be explored [30]. Due to the low traffic that the Internet was capable of managing, the increase of the quantity of users and the limitations of the computers in those years, similar VWs ended up disappearing. However, this is not the case of Worlds.com which nowadays is still alive. [30]

Around 2000-2010 the advancements in networks, graphics and the computer capabilities allowed for more complex VW such as Second life, Habbo or IMVU . This has led to the creation of large communities from around the world that could interact with each other exploring areas, building worlds or designing avatars. However, the possibility of buying or selling things was delimited by the fictional currency of the VW, being not possible to earn “real” money.

Afterwards, the evolution of the cryptocurrencies and the apparition of Web3 technology made it easier to join VW with blockchain technology into decentralized virtual worlds. Before Decentraland was converted to a decentralized virtual world, it started with the idea of having a 2D digital real estate where users could buy parcels on a blockchain. This was called the Decentraland’s Stone age. In 2016 they developed the Bronze Age, which was a 3D virtual world divided into parcels. [4]

Other types of platforms have exploited this concept of a virtual world divided into lands. One example of this type of platform is Earth 2 [7]. In this type of metaverse the users can buy the available land tiles, which make reference to real locations in the real world.

4.Background, terminology and definitions

Background

The founders of Decentraland, Ari Meilich and Esteban Ordano, created this platform in 2015 [4]. Two years later they launched it, with parcels sold for $20 and the Decentraland's coin, MANA, sold for about $0.02. It began as a proof of concept, with the idea of assigning ownership to the users of the virtual world on the blockchain. For this reason they also created the smart contracts of the platform. Initially, Decentraland was a 2D virtual world that slowly converted into a 3D world. The first map that was created was Genesis City. This map contained 90,601 parcels of land. They did an initial coin offering (ICO), which obtained $26 million in 2017 [3].

Decentraland

In April 2021, the popularity of NFTs increased the prices of the parcels, sold for $6,000 to more than $100,000. Since the pool of MANA is to an extent small, the currency is still not very stable. Events like the Facebook change of corporate name to Meta have spiked the currency up to $5.79 due to the interest of Meta in this emerging technology. The highest peak happened after the rebrand due to the purchase of the "largest metaverse land acquisition in history" made by Tokens.com, peaking at $5.90 in late November 2021.

In late 2021 and early 2022, a virtual state-estate company purchased a portion of land for $2.43. Afterwards, known brands started to have interest in Decentraland, buying properties in this platform [3]. For example, Samsung, Adidas and Atari. In addition, the world of fashion entered the virtual world as well and brands like Dolce & Gabbana, Tommy Hilfiger and Estée Lauder. There have been fashion events done on this platform and music concerts where artists such as Deadmau5 and Grimes performed in Decentraland. In March 2023, Decentraland had a market estimated value of $1.1 billion.

Terminology

Decentraland is a blockchain-based virtual world that offers a 3D environment made up of 90601 parcels of land. It is powered by the Ethereum blockchain and it combines VR and augmented reality (AR). [3] The users can be part of an extended reality (XR) experience where they can create, explore, interact with others and even monetize their content or the content of other users[6]. For example, they can play games, exchange collectibles, buy and sell NFTs , digital real estate or wearables for avatars.

The land of this platform is a digital asset that is non-fungible, transferable and scarce [4]. It is totally owned by the Decentraland's community, meaning that the users have full control over their creations. They can also manage the content that is published in their portion of land, which can range from static 3D spaces to interactive experiences. People can obtain land by spending an ERC20 token called MANA, which is also the coin of Decentraland that can be used for making purchases [4].

The landowners can control their land through the decentralized autonomous organization (DAO) which handles the most important smart contracts and assets of the platform. It includes the land contract, the states contract, wearables, content servers and the Marketplace. [5] Also, the users can propose policies and vote to decide how the world behaves.

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Definitions

- Initial coin offering (ICO): A type of crowdfunding that involves cryptocurrencies and can be used as a source of capital.
- Proof of concept: An idea that is an experiment or pilot project that goes through a process of verification with the objective of knowing the potential of it.
- Digital real estate: Similar to world real estate but the rules of Earth do not apply anymore. For example, buying parcels in another world is challenging since there are a limited number of parcels defined.

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5.Main description/analysis

Competitors of Decentraland

In our comparison, we will place a greater emphasis on prioritizing and exploring the differences between Sandbox and Decentraland rather than Somnium Space and Crytovoxels.

Sandbox vs Decentraland

Sandbox

Sandbox was initiated in 2012, but it was not until 2018 that it started using blockchain technologies. Sandbox, along with Decentraland, are now two virtual reality projects where users can create, play, and collaborate with others. Users can also purchase parcels, with Sandbox having approximately 166,000 while Decentraland has around 91,000. These parcels can be customized according to the users' preferences. On the other hand, land in Decentraland is currently being sold at a lower price: $5,000 or 3,800 MANA. [11,21]

Sandbox has an advantage over Decentraland in terms of scalability as it utilizes Polygon. The Polygon platform operates using the Ethereum blockchain and connects Ethereum-based projects. Utilizing the Polygon platform can enhance flexibility, scalability, and sovereignty of a blockchain project while providing the security, interoperability, and structural benefits of the Ethereum blockchain. Sandbox uses proof of stake for chain validation, which is more efficient, while Decentraland uses proof of work. [8]

Another important aspect is that Sandbox is not totally decentralized and is controlled by Aminoca Brands, which is a company, whereas Decentraland is governed by the aforementioned DAO. [8][9][10]

One thing they have in common is that both platforms are compatible with ERC-20 wallets. However, Decentraland recently added a new feature that allows Polygon users to interact with Decentraland, specifically with the wallet, making it better than Sandbox in terms of managing tokens and assets as well as lower gas fees. [11][20]

An important aspect to highlight is the source of finances. Decentraland has support from the government of South Korea, Samsung, Polygon, Digital Currency Group, FBG Capital, and Cypherpunk, among others. On the other hand, Sandbox has the support of the global Japanese company SoftBank, specialized in financial management. It also has financial support from various well-known companies like Slack and Uber. [11]

Decentraland uses the currency MANA, while Sandbox uses the currency SAND. As of June of 2023 MANA was priced at approximately $0.3279 USD per unit, and Sandbox was priced at approximately $0.3687 USD per unit. Mana appears to be slightly stronger than Sandbox, as Mana's value decreases at a slower rate than the latter. [22][32]

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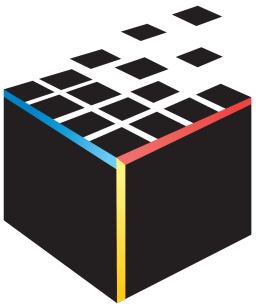
Somnium Space vs Decentraland

Somnium Space is a virtual reality (VR) world built on the Ethereum blockchain. With this open-source platform, users can buy land, houses, digital buildings, and various valuable assets within the game in their online metaverse. The immersive dynamics of Somnium Space allow players to build, navigate, and monetize environments while exploring the creations of other participants. Additionally, it features 5,000 parcels of land with different sizes. The more affordable lands in Somnium Space have a cost exceeding $5,600. [24][25][26]



Somnium Space

One advantage that Somnium Space can have is that it utilizes Proof of Stake instead of Proof of Work used by Decentraland, making it more efficient when it comes to block validation. [13]However, Decentraland is managed by DAO and Somnium Space is controlled by Somnium Space LTD although they have shown interest about DAO as well [31][14]. With an Ethereum wallet, players can possess ETH, CUBE, and NFTs (ERC721 tokens). Additionally, like Decentraland, the wallet is compatible with Polygon. [15]

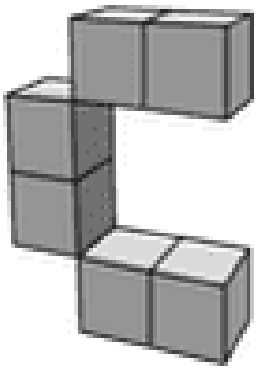
The platform has the support of a few renowned investors, such as the cryptocurrency exchange platform Gemini. The founder explains that the team explored the possibility of collaborating with major brands and working with some venture capital investors, but they didn't prioritize fundraising efforts as much as other metaverses that Business Insider has explored, like The Sandbox. [12]

Somnium Space has its own currency called CUBE, which has experienced a significant decline in price per unit at $0.09051 USD and did not seem to show signs of recovery in the mid-term due to its constant tendency towards $0.09 USD [26]. Although, as of June 2023 it is $1.13 USD.

Criptovoxels vs Decentraland

Cryptovoxels is a project that emerged in 2018 as a virtual world similar to Decentraland. It is a virtual reality platform hosted on the Ethereum blockchain and utilizes the ERC-721 token.

In this virtual universe, or Metaverse, which is self-funded through the sale of virtual parcels or lands on an expanding map, players can leverage the possibilities of NFTs and the decentralized economy. It contains around 5,000 parcels of land. The price of a parcel (land) in Cryptovoxels varies from 0.20 ETH (366€) to 15 ETH (27,344 €). [16][19][27]



Criptovoxels

One common feature between Decentraland and Cryptovoxels is that they both utilize the Proof of Work algorithm for block validation [28]. Another notable similarity between Decentraland and Cryptovoxels lies in the fact that they are governed by DAOs, the Decentraland DAO and LandWorks for land renting respectively. [29]

There is an ERC-721 and ERC-1155 marketplace that supports Ethereum and Polygon and allows players to buy and sell parcels, accessories and other NFTs using ETH or MATIC. Cryptovoxels also provides a wallet compatible with Polygon, similar to Decentraland. [18]

There are no details available about their investors as they haven't been made public. However, it is known that a setback for Cryptovoxels investors is that it no longer has its own currency. Despite these setbacks, there are many positive aspects. On one hand, users can expect the same experience in Cryptovoxels, whether on their mobile phones or desktop computers. [17]

Cryptovoxels does not have its own currency. The lack of a specific token in Cryptovoxels can be considered a disadvantage compared to platforms like Decentraland, which have their own currency (MANA). A native token can provide certain advantages, such as greater control over the internal economy, the ability to establish monetary policies and specific rewards. [18]

6. Implementation description

Before starting the explanation of the procedures followed, we have to state the steps accorded to reach the objective, that can be reduced in three: creation of the scene [33], addition of the *Donation Box*, publish and do the transaction.

The software used to develop this part consists of Visual Studio Code and the library of SDK. The tools used to publish and do a transaction are a wallet, like MetaMask, with some ethereum, as there are gas fees applied to any transaction done. Also, as it is obvious, an account of Decentraland is needed, to be able to buy or rent some land and publish scenes (we'll provide more detail about this in the next section).

So, after this small introduction about the implementation, let's keep going. When the Decentraland extension to Visual Studio is downloaded, we can create predefined scenes (there are 7 different ones) and, using those as a starting point, to have all the needed files to proceed, we planned what to do next.

There are lots of files when initializing a mock scene: several json files are created with all the information of the project, containing the dependencies and its versions, some scene configurations about positioning, size, and more details, and all the packages used in the project. These packages are automatically generated as well in a folder called "node_modules" when locally deployed.

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To create the fortress several things are needed: first, the 3D objects that will appear in the scene, as well as their 2D images for a preview and a color palette that is used for the builder to understand its colors. Second, create all the objects through programming and add them to the main file: *game.ts*. The creation of the non-animated objects is relatively easy, as all of them use the same procedure:

1. Create a new Entity, which will be the object.
2. Set this entity's parent as the scene itself, previously instantiated.
3. Get its 3D model as a *gltfShape* and set its properties, for example if it is visible, it allows collisions, etc.
4. Add it to the scene, using the method *addComponentOrReplace*
5. Set its positioning using *Vector3,* the rotations using *Quaterion* and the scale of the object.
6. Finally, using the *addComponentOrReplace* method, add the coordinates mentioned before.

For the fortress we needed a small amount of objects: walls and corner walls mainly, with some decoration such as a table, two sofas, a bike and a carpet. The roughest part was to find the 3D models, but after navigating through different githubs, we were able to get them. The walls were easier to implement, as just modifying their position and rotation, we could reuse lots of lines of code.

Getting to the most important part of the code, we reach the *DonationBox.ts.* There, we define in a similar way as explained before the Donation Box itself, and the method is then called in the *game.ts* file, as it is the one that creates the scene.

In *donationBox.ts* we call the 3D model to be able to show it in the scene, but now, as we are going to call it in another file, we have to create a constructor, where we will define the position of the donations box in the scene and the amount of money that will initially be displayed in the UI as a guide. This UI is the one that prompts when clicking on the box and lets the user choose the amount of MANA to be donated, with its background text as an image, and its properties about positioning and interactions with the users.

Some other properties are also set in the constructor, related to the animation that the box produces (small rotation) and its usage, which is to donate money to the address selected.

Getting on this point, the only missing thing is the money transfer method. We called it *makeDonation()* and it takes place when entering the money in the UI and pressing accept. It is an easy method, as the important line of code is: *"crypto.mana.send(this.address, this.defaultAmount)",* which uses this "send" function from an imported package, making the sending of MANA coins really straight forward.

After putting everything in *game.ts* and selecting one of our addresses from a wallet, we managed to see the scene locally, to get certification that everything was working correctly.

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7.Publishing a scene into Decentraland

We now enter the final stage of our project. The research and comparisons have been done, we have successfully created our scene, and everything inside it, and we have been able to make a local deploy. Thus, the only thing left to do is deploying it on the decentraland mainnet, public to everyone. There are, however, a few previous steps that need to be taken into account before that happens.

The first thing that we need is owning LAND permissions somewhere in Decentraland. There are two ways of getting such permissions; one is buying a parcel, which is quite expensive, as prices start at around 2.5K MANA (850$ aprox.), and the other one is renting a parcel, hence getting the permissions we need for a period of time, and as affordable as 3€ for 7 days (7 MANA aprox). Once we found a parcel that satisfied our needs, the next step was to purchase some MANA.

Decentraland offers a very simple way of buying their cryptocurrency, as one can pay with regular cards or bank transfers. However, we needed to store those tokens somewhere and we decided to do so in a MetaMask wallet. MetaMask is an extension for accessing Ethereum enabled distributed applications, or "Dapps". The extension injects the Ethereum web3 API into every website's javascript context, so that dapps can read from the blockchain. MetaMask also lets the user create and manage their own identities, so when a Dapp wants to perform a transaction and write to the blockchain, the user gets a secure interface to review the transaction, before approving or rejecting it [34].

Once we had an account, we purchased a small amount of MANA in our recently created wallet. But there was one last thing to consider before we could rent the LAND. As we learned in class, when a transaction wants to get in the blockchain, a gas fee must be paid, and as we were in the Ethereum network, we needed a small amount of ETH to pay such fees. Thankfully, a member of the group had some in Binance, a cryptocurrency exchange, and so all we had to do was transfer a small amount to the wallet (it is very easy to transfer money from Binance to any wallet, all we had to do was put the corresponding address and wait for its completion).

After all these processes, which took some interesting learning to do, we had everything we needed. We had our wallet, with some ETH and MANA, and were ready to rent the parcel and deploy our scene. So now we need to go back to the SDK in VScode.

There are a couple of ways to publish a scene, we could use a button provided by the SDK, or running "*dcl deploy*" through the command line. Anyways, once done, a pop-up was shown directly in VScode, but you could choose to move it to the browser, whichever you preferred. The scene needed to comply with the restrictions of the parcel (coordinates, size, etc.) in order to be able to perform the deployment, but it was an easy task to do, even after the scene was already programmed. With the scene online, we got in and tested its functionalities to check that everything worked fine. After the renting period ends, our scene's state will change to offline and the permissions of the LAND will return to its owner.

8. Conclusions

In conclusion, our analysis focused on Virtual Worlds, their advancements and how in combination with blockchain technologies have contributed to the emergence of Decentralized Virtual Worlds. Then, we have explained the beginnings of Decentraland and compared it to its competitors (SandBox, Somnium Space and CryptoVoxels), evaluating the advantages and disadvantages such as organizational structure, consensus mechanisms (PoW or PoS) and other factors. Additionally, we successfully developed a scene in the Decentraland virtual world, incorporating graphics and implementing a basic contract for sending MANA to an address. This aims to showcase our theoretical and practical learning process, as well as an understanding of the Decentraland ecosystem.

After doing this research, we think that Decentraland in general offers better features, especially in terms of decentralization, in comparison with the competitors although we also think that the Sandbox can be a good alternative due to the advantages that Polygon gives. Nonetheless, it also depends on the preferences of the user so having different options lets the user decide. Finally, decentralized virtual worlds are a new technology that due to the interest from users, brands of different kinds and the possibility of obtaining benefits through cryptocurrencies will continue growing in the future.

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REFERENCES

1. Wikipedia contributors. (2023). Virtual world. Wikipedia. https://en.wikipedia.org/wiki/Virtual_world
2. Jackob, A. (2023, January 25). The Metaverse's Evolution: Understanding the Impact of Decentralized Virtual Worlds. Medium.https://medium.com/geekculture/the-metaverses-evolution-understanding-the-impact-of-decentralized-virtual-worlds-3b41790718b0
3. Wikipedia contributors. (2023a). Decentraland. Wikipedia.https://en.wikipedia.org/wiki/Decentraland
4. Ordano, E.,Meilich,A.,Jardi, Y. & Araoz M.Decentraland white paper. https://decentraland.org/whitepaper.pdf
5. Decentraland DAO. (n.d.). Decentraland DAO. https://dao.decentraland.org/en
6. Lodge, M. (2023). What Is Decentraland? Investopedia. https://www.investopedia.com/what-is-decentraland-6827259
7. Earth 2®. (n.d.). Earth 2®. https://earth2.io/
8. Maldonado, J. (2022). Todas las diferencias entre los metaversos The Sandbox y Decentraland. *Noticias Blockchain | Observatorio Blockchain*. https://observatorioblockchain.com/metaverso/todas-las-diferencias-entre-los-metaversos-the-sandbox-y-decentraland/.
9. Lanz, M. T. (2022, 5 marzo). Decentraland vs. The Sandbox: conoce las diferencias de sus metaversos. *Morocotacoin.news*. https://morocotacoin.news/ecosistema/decentraland-vs-the-sandbox-conoce-las-diferencias-de-sus-metaversos/.
10. Taylor, G. (2023, 7 febrero). Decentraland (MANA) VS Sandbox (SAND) — Still Profitable in 2023? *Medium*. https://medium.com/coinmonks/decentraland-mana-vs-sandbox-sand-still-profitable-in-2023-cd3055089c78.
11. ZenLedger. (2023). Sandbox Vs Decentraland: Which is a Better Metaverse? *ZenLedger*. https://www.zenledger.io/blog/sandbox-vs-decentraland.
12. Cáceres, I. (2022, 15 mayo). Somnium Space: análisis, opiniones y guía del metaverso de realidad virtual. *Business Insider España*. https://www.businessinsider.es/somnium-space-analisis-opiniones-guia-metaverso-realidad-virtual-1051561.
13. Russell. (2021). Somnium Space Land Offering Brings Solana Into the Fold. *NFT Plazas*. https://nftplazas.com/somnium-space-tertiary-land-offering/.
14. *Karma and Achievements in Somnium Space*. (2021, 25 diciembre). Somnium Times. https://somniumtimes.com/2021/12/04/karma-and-achievements-in-somnium-space/.
15. Admin. (2022, 18 junio). *Connect Polygon to your wallet*. Somnium Space Guide. https://somniumspace-guide.com/?page_id=134.
16. Pérez, E. (2022). Cryptovoxels: Qué es, cómo funciona y qué podemos hacer en este metaverso. *GizTab*. https://www.giztab.com/cryptovoxels-metaverso-tokens/.
17. Montaner, D. (2021). Explorando el mundo virtual de Cryptovoxels. *CriptoMundo*. https://criptomundo.com/explorando-el-mundo-virtual-de-cryptovoxels/

18. Hickey, B. (2021). Cryptovoxels metaverse game guide. *finder.com*. https://www.finder.com/cryptovoxels-guide.
19. Canelles, E. (2022). Lands en el metaverso: qué son y cómo beneficiarán a tu empresa. *Digital Tactics 360*. https://digitaltactics360.com/lands-en-el-metaverso-que-son-y-como-beneficiaran-a-tu-empresa/.
20. *Polygon PoS | The most efficient blockchain protocol*. (s. f.). https://polygon.technology/polygon-pos.
21. Cripto, R. (2022, 14 junio). Bajan los precios de los terrenos en el metaverso: ¿es momento de comprar una parcela? *Cripto247*. https://www.cripto247.com/comunidad-cripto/bajan-los-precios-de-los-terrenos-en-el-metaverso-es-momento-de-comprar-219065/
22. *Precio, gráficos, capitalización de mercado de Decentraland (MANA) | CoinMarketCap*. (s. f.). CoinMarketCap. https://coinmarketcap.com/es/currencies/decentraland/.
23. Sanchez, G. (2022, 22 julio). ¿Qué es Somnium Space Metaverse? *MiT Software*. https://mitsoftware.com/que-es-somnium-space-metaverse/.
24. Hoogendoorn, R. (2021). Somnium Space Makes Waterfront Parcels Even More Interesting. *Play to Earn*. https://www.playtoearn.online/2021/04/09/somnium-space-makes-waterfront-parcels-even-more-interesting/.
25. Torrejon, M., & Torrejon, M. (2020). Somnium Space migra su plataforma a la infraestructura de alto rendimiento de Matic. *Bitcoin.es tu portal de información de criptomonedas*.https://bitcoin.es/noticias/somnium-space-migra-su-plataforma-a-la-infraestructura-de-alto-rendimiento-de-matic/.
26. *Precio, gráficos, capitalización de mercado de Somnium Space Cubes (CUBE) | CoinMarketCap*. (s. f.). CoinMarketCap. https://coinmarketcap.com/es/currencies/somnium-space-cubes/.
27. *A blocky metaverse*. (s. f.). https://www.voxels.com/.
28. Ola. (2022). CryptoVoxels' Offsetra Partnership Aims To Offset Carbon Footprint. *NFT Evening*. https://nftevening.com/cryptovoxels-offsetra-partnership-aims-to-offset-carbon-footprint/.
29. Todorov, Z. (2022, 23 abril). Cryptovoxels and EnterDAO partner up to bring permissionless land renting through LandWorks. *Medium*. https://medium.com/enterdao/cryptovoxels-and-enterdao-partner-up-to-bring-permissionless-land-renting-through-landworks-f8ca94b218bb.
30. Wikipedia contributors. (2023). Worlds.com. *Wikipedia*. https://en.wikipedia.org/wiki/Worlds.com
31. Somnium Space Ltd. (n.d.). Somnium Space.https://somniumspace.com/terms-conditions/faq
32. *Precio, gráficos, capitalización de mercado de The Sandbox (SAND) | CoinMarketCap*. (s. f.). CoinMarketCap. https://coinmarketcap.com/es/currencies/the-sandbox/
33. decentraland-scenes. (n.d.). GitHub - decentraland-scenes/Awesome-Repository: A collection of links to examples and tutorials to help you get started building Decentraland scenes and other content. GitHub. https://github.com/decentraland-scenes/Awesome-Repository

34. *MetaMask*. (n.d.). Chrome Web Store. https://chrome.google.com/webstore/detail/metamask/nkbihfbeogaeaoehlefnkodbefgpgknn?hl=es