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Master Thesis

Real Estate in the Metaverse

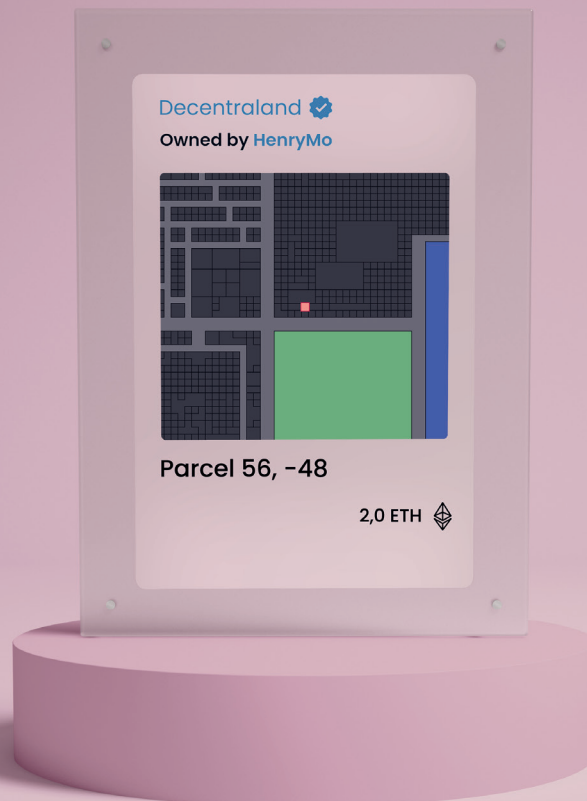
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Abstract

IT

Il web 3.0, vera rivoluzione del web, sta prendendo piede e si sta rivelando un mondo sempre più concreto che sembra non fermarsi. L'era del metaverso sta prendendo il via, un periodo storico in cui la realtà virtuale ed il mondo reale vanno di pari passo, definendo un concetto totalmente nuovo di vita digitale. In merito a ciò vi sono pareri discordanti: c'è chi crede che il metaverso sia una bolla temporanea e chi invece pensa che andrà ad influenzare molti aspetti della vita delle persone. È con quest'ultima che le previsioni di mercato sono in forte accordo. La parte più interessante, da cui è scaturita

l'idea per questa ricerca, e di conseguenza la stesura della mia tesi, è quella relativa al real estate virtuale; si tratta di un nuovo mercato emergente, strutturato in maniera simile al real estate fisico. Circa questo argomento, essendo così recente, si ha poco materiale al quale attingere ed è proprio con il fine di far luce e chiarezza che ho impostato la mia ricerca. Si parla di un settore che ha un grande potenziale di investimento e ciò avviene attraverso un'analisi approfondita effettuata con una chiave di lettura finalizzata al paragone con il mondo reale, arrivando infine ad una valutazione del valore di mercato.

EN

Web 3.0, the real web revolution, is gaining ground and proving to be a more and more concrete world that doesn't seem to stop. The metaverse age is taking off, an era where the enduring virtual reality and real world unfold hand in hand, defining a totally new digital life concept. Nonetheless, there are different opinions: some believe that the metaverse is a temporary bubble, while others think that it will affect many aspects of people's lives, with which market forecasts are in solid agreement. The most exciting part,

which gave rise to the idea for this research, is that relating to virtual real estate, a new emerging market structured in a similar way to physical real estate, but because very recently, the connected literature is extremely little. Consequently, the proposed research aims to highlight a sector with considerable investment potential. It does so through an in-depth analysis carried out with a key to a comparison with the real world and an evaluation of the market value.

Excerpt

IT

Sta diventando chiaro che il Metaverso, in particolare tutto il web 3, sta iniziando a intrecciarsi con il mondo reale e il settore immobiliare. Ma ciò che più incuriosisce è l'introduzione di un concetto fondamentale: la terra virtuale.

A seguito della crescente popolarità del metaverso, conseguente all'annuncio di Meta nel 2021, molti marchi, investitori e utenti stanno acquistando terreni virtuali. Tra i tanti acquisti nel metaverso, uno dei più interessanti è avvenuto nel 2021 nell'ambiente di Decentraland, dove l'acquirente, Tokens.com, ha acquistato un lotto di 116 lotti per la cifra record di 2,4 milioni di dollari USA. (Bourke & Hymers, 2022)

Il metaverso sta indubbiamente facendo notizia, pur tra alti e bassi, e l'obiettivo di questa analisi è fare luce sul terreno digitale confrontandolo con quello fisico.

Ma cosa significa "Metaverso"? Meta lo descrive come un insieme di spazi virtuali in cui puoi creare ed esplorare con altre persone che non si trovano nel tuo stesso spazio fisico. (Meta, 2021). Partendo dall'etimologia della parola, il prefisso

"meta", che significa "più completo" o "trascendente", deriva dalla lingua greca, mentre la parola "Verso" sta per "universo", che significa un contenitore spazio-temporale. (Gadekallu, et al., 2022)

Questo concetto è stato inquadrato per la prima volta nel romanzo di fantascienza "Snow Crash" scritto da Neal Stephenson nel 1992 (Anurag, 2022), che descriveva il Metaverso come una realtà parallela, un complesso agglomerato di mondi virtuali formanti un universo (Stephens, 2021). Successivamente, il grande Steven Spielberg ha raffigurato il Metaverso nel film Ready Player, portando il pubblico a un'autentica ammirazione per questo spazio di vita digitale evoluto e ispirando all'improvviso i giganti della tecnologia a investire nello sviluppo di questo concetto (Gadekallu, et al., 2022).

Il Metaverso può essere delineato come un mondo virtuale tridimensionale che mira alla creazione di esperienze 3D estremamente personalizzabili per gli utenti, che possono interagire attraverso i loro avatar in una modalità evoluta di social network (Gadekallu, et al., 2022).

Detto questo, è importante segnalare gli asset presenti nel Metaverso, che sono gli NFT, token non fungibili quindi unici e non intercambiabili. Inoltre, la presenza della blockchain garantisce a ciascun metaverso di avere il proprio “ecosistema finanziario”, noto anche come Criptovaluta (Nakavachara & Saengchote, 2022).

Attualmente il metaverso è costituito da una molteplicità di piattaforme, dove è possibile costruire di tutto, “dai giochi in miniatura nei cimiteri infestati ai cartelloni pubblicitari o distretti commerciali e quartier generali del metaverso per attività già stabilite nel mondo reale” (Waterworth, 2022). Le piattaforme possono essere suddivise in due grandi categorie differenti:

Spazi virtuali - Queste piattaforme aiutano a navigare in progetti e piccole aree, che non sono collocate in mondi aperti, ma in stanze virtuali dove le persone possono visitare, giocare e interagire. Ciò significa che ogni spazio è disconnesso dagli altri.

Mondi virtuali - Un concetto di piattaforma completamente diverso, sono proprio come le città digitali, dove è possibile acquistare immobili, costruire progetti e interagire con gli utenti come nel mondo reale.

2,4 milioni di dollari USA: questo è il prezzo da re-

cord pagato per un lotto digitale in The Sandbox nel 2021. L’investimento della società Republic Realm è consistito nella costruzione di 100 isole, 90 delle quali sono state immediatamente vendute per \$ 15.000 a testa. (Alkhaldi, 2022)

Le persone acquistano, costruiscono e utilizzano proprietà virtuali in modi creativi, il che sta creando nuove prospettive per il mercato immobiliare tradizionale nel metaverso, questo è possibile grazie alla tecnologia blockchain e AR/VR. (Deloitte, 2022)

Ma cosa rappresenta l’immobiliare nel metaverso? Rappresenta lotti di terreno virtuale che possono ospitare edifici commerciali, residenziali e molte altre tipologie. Gli utenti possono costruire qualsiasi tipo di proprietà sul sito, inclusi cartelloni pubblicitari, quartieri degli affari e sedi di vere e proprie società. Gli immobili di Metaverse sono ambienti programmabili su varie piattaforme in cui gli utenti possono interagire socialmente, giocare, scambiare NFT, commercializzare i propri beni e servizi e persino partecipare a riunioni di lavoro utilizzando avatar 3D. (Alkhaldi, 2022)

Introduction

Luxforsale, a luxury portal based in Sanremo that deals with the real estate transaction, has announced the possibility of buying an apartment in Milan in cryptocurrencies worth 940 thousand euros. The apartment is located in a building in the Cinque Giornate area and is owned by a well-known Italian director from Milan, passionate and competent in the digital market which includes cryptocurrencies, NFT and metaverse.

Claudio Citzia, CEO and head founder of Luxforsale, revealed that it is an absolute novelty in the Italian real estate scene, and that it represents an important operation on which is worth to pay close attention (Ansa.it, 2022). Indeed, this is a great novelty for Italy as it represents the first case of sales with cryptocurrencies: this is proof of the fact that this world is constantly evolving.

The difference between the purchase made with current currency and one made in the digital world is that the former, like any case of sale, would involve different bureaucracy and could lead to legal checks. In the second case, however, the purchase would be much faster, easier and free from the limits imposed by bureaucracy.

In fact, cryptocurrency has all the characteristics to become a very popular currency in real estate sales, also because it allows the buyer to monetize that investment in crypto made much earlier. This deed of buying and selling in cryptocurrencies means that even in Italy, the real estate sector encounters crypto, NFTs and the metaverse.

Luxforsale explains that the reasons for deciding to buy a luxury home in crypto are many and among them we find the fact that it represents a way to make a small investment in Bitcoin or Ethereum made years ago more solid, which today can be reinvested in part or in whole in the property. (Stimolo, 2022).

Nonetheless, what really stands out is the fact that the seller, in addition to the “non fungible token” (NFT) – representing the virtual certificate of authenticity of the property –, offers 3 “virtual lands” bought in the metaverse. These lands, in fact, correspond to the exact area of the house but in the digital world. Citzia also states that the virtual property gifted with the purchase of the physical property could one day be worth more than the property itself. (Stimolo, 2022).

It’s becoming clear that Metaverse, particularly web 3, are starting to intertwine with the real world and physical real estate. But what’s intriguing is the introduction of a fundamental concept: the virtual land.

As a result of the increasing popularity of the metaverse, consequent to Meta’s announcement in 2021, many brands, investors and users are buying virtual land. Among the many purchases in the metaverse, one of the most interesting took place in 2021 in the Decentraland environment, where the buyer, Tokens.com, bought a 116-parcel lot for a record-breaking price of 2.4 million US dollars. (Bourke & Hymers, 2022)

Metaverse is undoubtedly making the news, even between ups and downs, and the goal of this analysis is to shed light on the digital land comparing it to the physical one.

1



What is the metaverse

What does “Metaverse” mean? Meta¹ describes it as “a set of virtual spaces where you can create and explore with other people who aren’t in the same physical space as you.” (Meta, 2021) Starting from the etymology of the word, the prefix “meta,” which signifies “more complete” or “transcending,” comes from the Greek language, while the word “Verse” stands for “uni-verse,” which signifies a space-and-time container. (Gadekallu, et al., 2022)

This concept has been framed for the first time in the science fiction novel “Snow Crash” written by Neal Stephenson in 1992 (Anurag, 2022), which described the Metaverse as a parallel reality, a complex agglomeration of virtual worlds forming a universe (Stephens, 2021). Later, the great Steven Spielberg depicted the Metaverse in the movie Ready Player, leading the audience to an authentic admiration towards this evolved digital living space and inspiring all at once the tech giants to invest in developing this concept (Gadekallu, et al., 2022).

In October 2021, when Facebook suddenly changes its name to “Meta” leading to its conversion into a Metaverse company, it suddenly catches public attention, becoming subject of numerous discussions, gaining sympathy and reaching the peak of its notoriety (Nakavachara & Saengchote, 2022).

The Metaverse can be outlined as a three-dimensional virtual world that aims to the creation of extremely customizable 3D experiences for users, which can interact through their avatars in an evolved social network modality (Gadekallu, et al., 2022).

That said, it is important to point out the assets present in the Metaverse, which are the **NFTs**, non-fungible tokens which are therefore unique and not interchangeable. Furthermore, the presence of the **blockchain** grants each metaverse to have its own “financial ecosystem”, also known as **Cryptocurrency** (Nakavachara & Saengchote, 2022).

Currently the metaverse is made up of a multiplicity of platforms, where you can build everything, “from miniature games in haunted cemeteries to advertising billboards or commercial districts and metaverse HQs for businesses already established in the real world” (Waterworth, 2022). The platforms can be divided into two big different categories:

Virtual spaces - These platforms help navigate projects and small areas, which are not placed in an open worlds, but in virtual rooms where people can visit, play and interact. This means that each space is disconnected from the others. One of the most famous is Spatial², which is virtual and augmented reality platform that let user create their virtual 3D space/workspace and collaborate inside it.

Figure 2. | Escape by The Pink Lemonade and SuperRare (project by Massimo Devino) - hosted on spatial.io

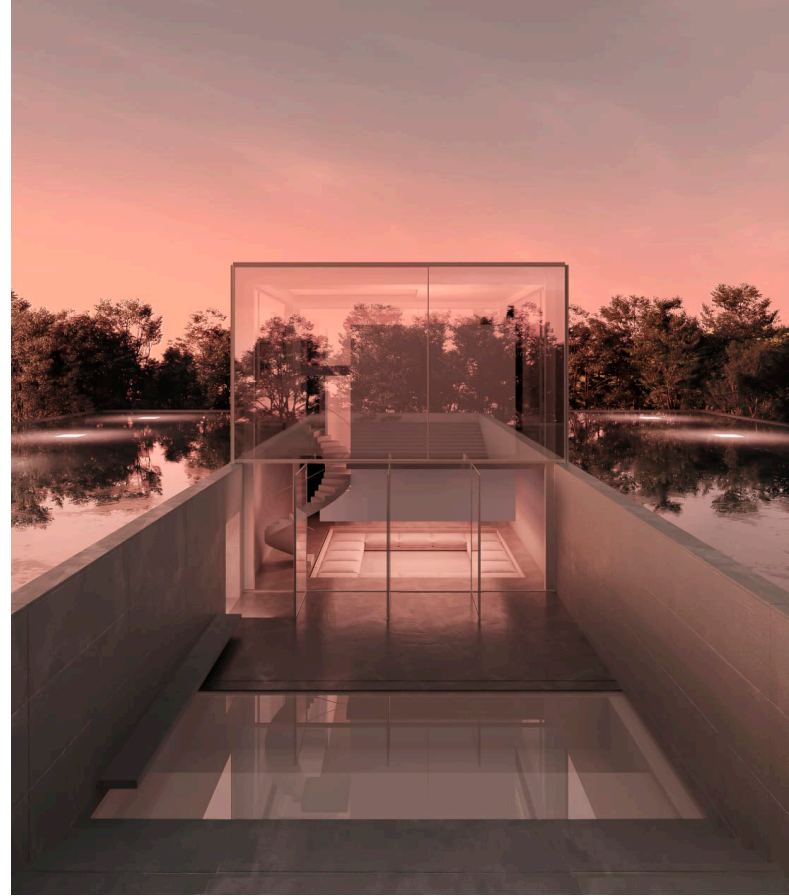
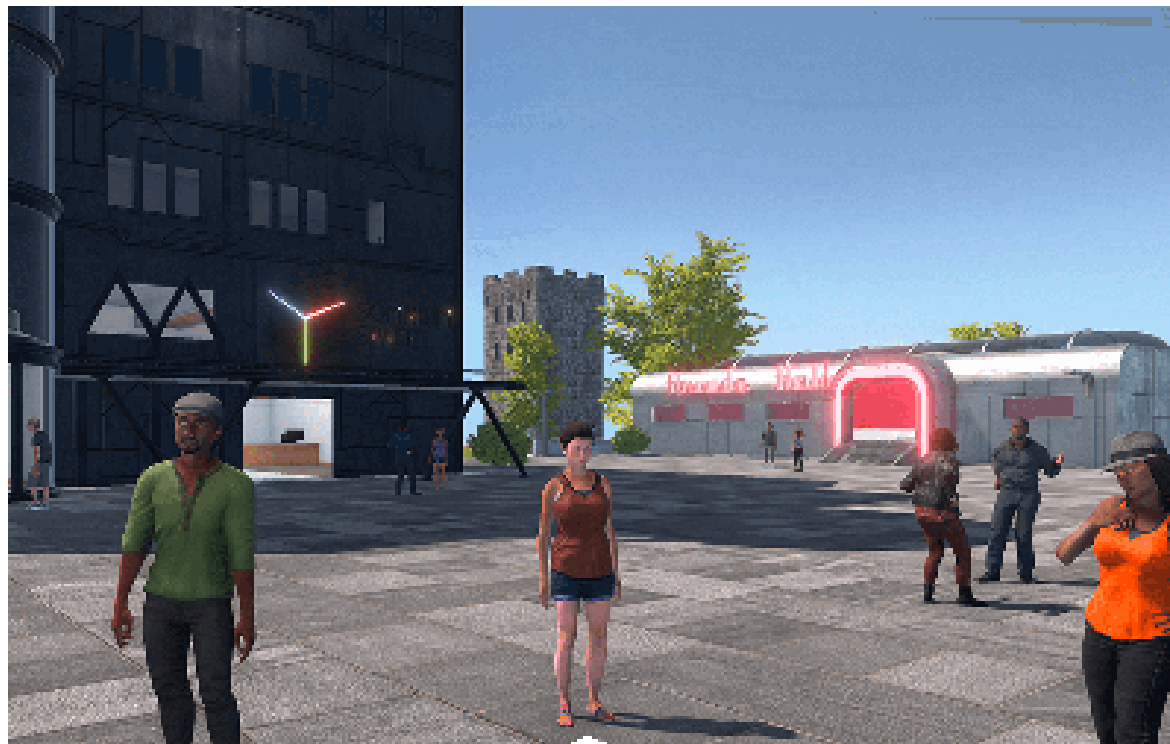


Figure 1. | The Row's homes - Andres Reisinger & Alba de la Fuente/Everyrealm

Virtual worlds - A whole different concept of platform, they are just like digital cities, where it's possible to buy real estate, build projects and interact with the users like in the real world. While a large number of platforms allows the purchase of real estate, the most notable ones are mainly four: The Sandbox, Decentraland, CryptoVoxels and Somnium Space. (Deloitte, 2022), (Gadekallu, et al., 2022) (Waterworth, 2022)

Figure 3. | Somnium Space platform (Somnium Space)



In the metaverse platforms built on the blockchain there are currently two ways of logging-in in the virtual world, which are: web 2.0, such as a user registration or a “sign up with Google”; and web 3.0 (web3), which is the real game changer, because it allows the user to log-in with their crypto wallet and consequently take advantage of the security of the blockchain, buy, sell and much more.

While the concept of metaverse has been well known for the past decades, the pandemic has played a significant role in bringing closer to the public the idea of a digital collective space. (Stephens, 2021) Furthermore, it pushed a substantial transformation towards the digitalization of services in several fields; for these reasons the Metaverse is considered to be the new frontier of digital evolution, in continuous and persistent growth and evolution. (Stephens, 2021)

The increased popularity of the immersive capabilities of the platforms, which require the use of the newest technologies such as Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and Extended Reality (XR), has brought to a loud demand of these systems by the costumers. (Gadekallu, et al., 2022)

1.1 Technologies →

While the main functions and benefits of the Metaverse have been introduced, it is necessary to explain how the platforms are able to preserve the security of their users' data and content.

In fact, the blockchain is a solution that offers transparency, decentralization and immutability and although metaverses can exist without being built on the blockchain, it is very unpleasant. (Gadekallu, et al., 2022)

To properly assess this matter, it is necessary to highlight the most urgent discrepancies between the newest Metaverses, which are mostly – but non exclusively– created on a blockchain and therefore publicly controlled by the will of the users, and the already existing digital game platforms (such as Minecraft, Second Life or Roblox), which are not built on the blockchain. (Na-

kavachara & Saengchote, 2022) (Anurag, 2022) (Heath, 2022)

The downside of these platforms is that the centralized authorities have full ownership of the users' assets, as it could happen for instance with Apple and Meta metaverse projects; for this reason, the blockchain is necessary in the metaverse. (Anurag, 2022) In fact, in order to provide true ownership of an asset to the users, the metaverse should be owned by the users and no central authority should have any right over their data, which can't be edited or manipulated in any way since it is based on the blockchain. (Anurag, 2022) That is why Web 3.0 is considered to be the base of Metaverse, a user owned internet where centralized entities do not have the power to control them. (Anurag, 2022)

1.1.1 Blockchain

In 1991 blockchain technology was disclosed by the researchers Stuart Haber and W. Scott Stornetta, who were willing to elaborate a system that could assure the impossibility to manipulate document timestamps. (Anon., s.d.)

Furthermore, the first concept of blockchain can be found in a white paper written by Nakamoto Satoshi in 2008 (Nakamoto, 2008) and can be identified through the goal of allowing information to be recorded and distributed, but not modified. (Hayes, 2022) However, we have to wait until January 2009 with the launch of Bitcoin to witness the first actual application of the blockchain, which led it to fame and characterized it as a breakthrough technique in safeguarding the security and privacy of digital data.

Subsequently to its launch with Bitcoin, nowadays there are a multiplicity of blockchains such as Ethereum and Solana. Furthermore, the use of the database is not strictly limited to financial transaction, but, on the contrary, it is also exploited in transfers of different typologies of data. (Giannelli & Tavoni, 2016-2017)

Blockchain, also called Distributed Ledger³ Technology, can be defined as a decentralized, tam-

per-proof, transparent, digital database made of consecutive blocks, which can hold data. This data can be constituted by a list of transactions, the cryptocurrency, legal contracts, and different other typologies of information. (Hayes, 2022)

A block is compiled, according to an hashing algorithm called hash function, which creates a unique fixed-length character string from all the information contained in a block, used as the block's header. (Giannelli & Tavoni, 2016-2017) [10] That said, before being added to the blockchain, the block is transmitted across a peer-to-peer network and authenticated through the consensus mechanism⁴ (such as proof of work (PoW) or proof of stake (PoS)). Consequently the blocks are linked with each other through the hash value of the previous block, creating in this way a chain of data. (Giannelli & Tavoni, 2016-2017)

The blocks can contain transactions or records, which become secure and decentralized thanks to the cryptographic measures used. (Gadekallu, et al., 2022)

Since every member in the network, known as a node, has the identical copy of the ledger, it is extremely difficult to disrupt or alter the records held within it, creating in this way, an irreversible timeline of data. (Himanshi, 2022)

That's why the revolution of the blockchain consists in the fidelity and security of a record of data, which creates an environment where trust is based on the technology and in the complexity of a cryptographic code without the need for a trusted third party or a central authority (Hayes, 2022) (Giannelli & Tavoni, 2016-2017) This is the definition of blockchain decentralization.

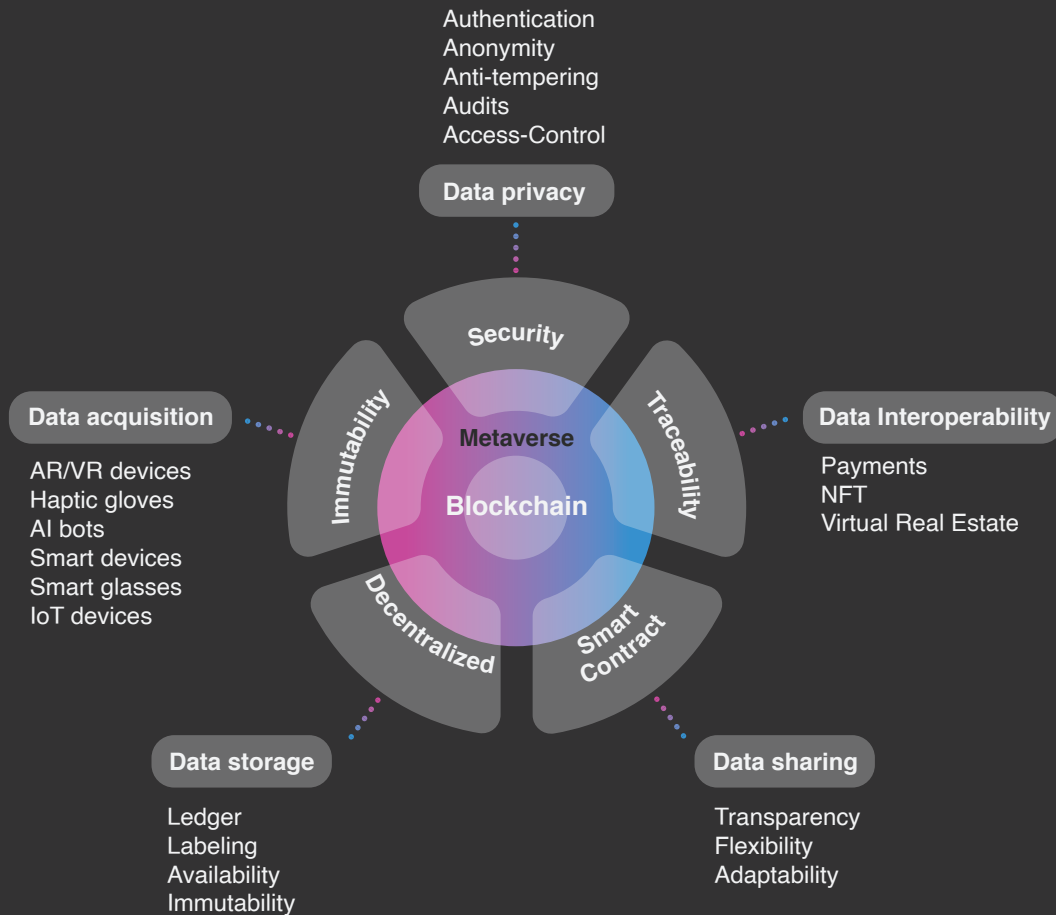
The decentralization character of the blockchain allows the total transparency of all the transactions to the point that each node or user obtains a copy of the data chain which receives continuous updates on the new operations executed. The stored records are, nonetheless, encrypted to allow the anonymity of the owner, who is the only user able to decrypt the record and reveal his identity, preserving the transparency of the digital ledger. (Hayes, 2022)

Blockchain, which can be defined as the soul of the decentralized metaverse, can provide many benefits to it. Besides NFTs, smart contracts and financial advantages (Tamper-proof, transparency, openness, and decentralization) mentioned before, data management is certainly not far behind since there is a substantial amount of shared sensitive information.

Once the data is acquired, blockchain can ensure its privacy, security, and quality, providing com-

plete audit trails of transactions. In addition, data storage and sharing, a fundamental aspect and concern for many stakeholders, is secure and seamless, giving integrity and interoperability of the data between virtual worlds. Consequently, this data transparency will be a great benefit for investors and users, ensuring their integrity, privacy, and reputation. (Gadekallu, et al., 2022)

Figure 4. | Blockchain Data Management (own elaboration based on (Gadekallu, et al., 2022) work)



1.1.2 Cryptocurrency

In his paper “Bitcoin: A Peer-to-Peer Electronic Cash System”, Satoshi Nakamoto depicted Bitcoin, the first cryptocurrency, as “an electronic payment system based on cryptographic proof instead of trust”. Therefore, a cryptocurrency is a decentralized digital asset that does not require a central monetary authority in order to operate, allowing customers to buy or trade in absolute security. (Voigt & Rosen, 2022) Currently there are more than 19,000 cryptocurrencies, the most popular are Bitcoin and Ethereum. [11]

Cryptocurrencies, which are supported by the blockchain technology (Voigt & Rosen, 2022), are indicated as coins or tokens and they can be identified as exchangeable units for goods and services, they can be stores of value or be used in gaming software or over financial products. (Voigt & Rosen, 2022) The main vantage of cryptocurrency stands in the fact that there is no central authority that manages it, because it is distributed through a peer-to-peer network.

As the name may imply, the word cryptocurrency was formed because it relies on cryptography, more specifically on the hash function, which requires a cryptographic proof in order to verify and record the transaction on the block-

chain. (Ashford, 2022) Bitcoin utilizes an algorithm called SHA-256, but not all cryptocurrencies do. (Bitstamp, 2022). They are created during a “mining” process, a highly energy-consuming procedure that aims to monitor the authenticity of the transactions through the consensus mechanism, solving challenging calculations through powerful computers in order to approve each transaction by the majority of ledger holders. (Ashford, 2022) Therefore, the owners of the mines earn as a reward for their work new cryptocurrency. (Voigt & Rosen, 2022)

1.1.3 NFT

The NFT market is currently worth more than \$7 billion dollar (Gadekallu, et al., 2022). The term is an acronym that stands for the expression “Non Fungible Token”, indicating a digital asset that is decentralized and secure just like cryptocurrencies, but at the same time is unique and not interchangeable due to its signature. (Nadini, et al., 2021) The rise of NTF has completely changed the way that ownership works, and its strength stays in the fact that is generally encrypted with smart contracts on a blockchain. (Smith, 2022) The blockchain, in fact, certifies the uniqueness of the digital asset and, thanks to the ledger used, of-

fers the certificate of authenticity which acts as proof of ownership. (Nadini, et al., 2021)

It can be said that ownership of physical and digital assets has always been difficult to track, this changes with NFTs because they are decentralized and immutable, so they can't be replicated or forged, therefore the ownership is authenticated and protected. (Smith, 2022) Apart from proving the actual ownership, it can also be established the "provenance" of the assigned NFT, proving the creator and all property details, as well as accurate ownership records, on the blockchain. (Smith, 2022)

This system allows the user to purchase a portion of any item together with different owners without the necessity of physically own it. The buyers can purchase NFTs with different utilities: the most popular ones differs from in-game assets or items to ensure a better experience in the gaming platforms, art pieces and collectibles, digital tickets for live events in the real world, equity in businesses, and everything that can be turned into a contract, even virtual real estate.

NFTs can be created in different blockchains, the most used one is currently Ethereum. As it was explained in the previous chapters, each blockchain has its own security protocols and methods of processing transactions, which generally

require a lot of calculations and computer power to solve. Therefore, due to the high transaction costs and environmental impact, various blockchains have been becoming popular in the NFT world. The security of the transaction between a buyer and a seller is solved by the safe environment created by NFTs, that ensure the possibility to find other users with whom finalize the supposed transaction and avoiding falling into scams or hacks. This is carried out without the necessity of sharing personal information or having to go through a mediator, assuring the security of ownership and without having to include physical files but only ownership records. (Smith, 2022) The proof of ownership ensures to the owner the possibility to sell his assets in the open market or buy fractions owned by others.

1.2 Metaverse Applications →

The applications of the metaverse and its technologies can be **endless** and comprehend various fields, here are collected the prominent ones. Many of them relies especially on the AR/VR experience.

One of the most discussed and studied in the last two years is the **working environment**, which has been affected and altered by covid19. Many people have been dealing with videocalls, impossibility to interact and many other difficult aspects. Metaverse can change remote work completely with virtual spaces where each participant will take part with his own avatar, along with the interaction in between employees in the new virtual offices, as Nike, McDonald's, YouTube, The Walt Disney Company like Meta are already working on with successful results.

tional ones. For instance the could learn global wars by being inside the recreation of the battles; and so much more. (PixelPlex, 2022) This examples show how this technology can solve remote interaction problems helping people to work wherever they are, but metaverse can do much more also in other fields; one of these is for sure **healthcare**. A crucial field, where there are currently lots of studies in order to implement the use of AR/VR technology which would give a fundamental improving to the preparation of medical students as well as in assisting surgeons during procedures; all of this could be done in a virtual hospital. Also the **military** sector showed many advantages, for instance the Synthetic Training Environment, which is an AR system that offers the possibility for soldiers to use virtual environments to simulate ultrarealistic physically and psychological intensive training experiences. (Howell, 2022) A similar development can be seen in the **manufacturing** field, which allows the employees to train and assure safety in virtual scenarios, that otherwise could be risky in the real world. (Howell, 2022)

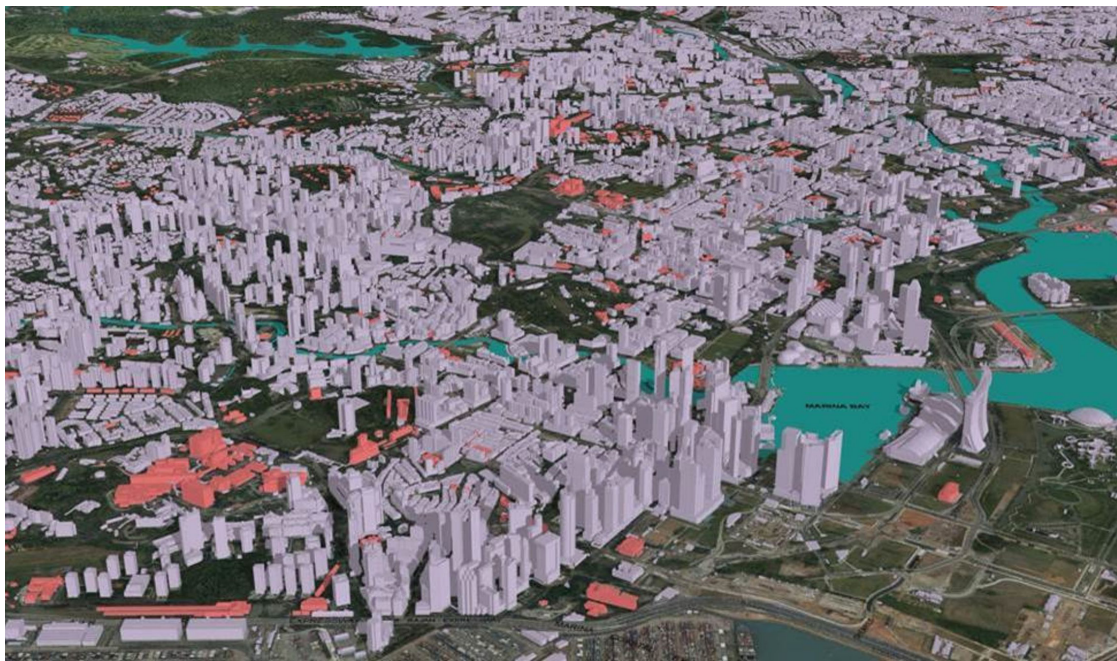


Figure 5. | Horizons Workrooms - (Meta)

Another interesting application of the metaverse is in the **urban planning field**: the creation of city clones, digital models of existing cities. In these replicas is possible to simulate different scenarios. These so-called “digital twins” are fundamental in projecting in the city new policies and innovative projects, to analyze their impact over time and therefore establish if the solution would have a positive outcome in the reality. Although many uses are still far from being achieved soon, several municipalities are embracing this technology to carry 3D mapping processes and analysis of static and real-time data. An example could be the case of the city of Orlando, which foresees the possibility to employ it in order to analyze how the transit system upgrade could impact the built environment. In addition, the city of Singapore is a pioneer in testing the newest

possibilities of this technology, as they collected billions of 3D data points and millions of pictures, with the goal to be more and more sustainable. Furthermore, this application could be extremely helpful in testing the effectiveness of many actions preventing the sea levels rise and urban heat. The statistics show that by 2030 digital twins could be able to avoid the cities an expenditure of \$280 billion. (Poon, 2022) In addition, the collected data can be used to develop immersive open-source cities which are able to mimic advanced decision-making. The platforms Realio plans to launch a digital twin in which the user is able to purchase, sell or build on land parcels all around the planet earth, providing new frontiers for architects and changing the way that users engage with businesses as visiting virtual stores with their own 3D avatar. (Das, 2022)

Figure 6. | Singapore’s digital model (Poon, 2022)



Similarly, the metaverse in the **tourism** field could allow the users to travel in the virtual space and is expected to hold a digital environment that merges the virtual and augmented reality, that will lead to a form of virtual tourism. As in the case of the Virtual Reality Holiday 'Try Before You Fly' by Thomas Cook that enables the users to experience their holiday in the virtual space before deciding whether to do it in the real world. (Echoworks, s.d.)

Also **Real estate** and **Architecture** firms can have many benefits from the metaverse application. Starting with the possibility to completely change virtual tours of not only already built properties but especially with new projects, which are not constructed yet. Studied has shown a drastically increase in value projects that allow the clients to have a virtual experience. (PixelPlex, 2022) Moreover the real estate sector could also be implemented with city clones, in order to obtain market trend predictions.

Last but not least, the **retail** and **fashion** industry, which is booming in the metaverse. Many brands such as Nike, Adidas, are building virtual shops and selling goods as NFTs. An interesting case is the "Metaverse design" by Gucci, in which the users can buy the collection from the platform. (PixelPlex, 2022) Apart from selling digital goods, the goal is to improve dramatically the shopping

experience, allowing people to buy real products in a virtual environment instead of a website.

To conclude, there are endless possibilities, and these applications show how many important future opportunities of growth can be developed.

2

Real Estate in the Metaverse



1.3 Literature review

To this day, metaverse real estate literature is not extensive. Five scientific papers, and their key conclusions and analysis are summarized below.

Paper	Publisher	Authors	Date
Does unit of account affect willingness to pay? Evidence from metaverse LAND transactions	Science Direct	Nakavachara, V.; Saengchote, K.	October 2022
Fertile LAND: Pricing non-fungible tokens	Science Direct	Dowling, M.	January 2022
Is non-fungible token pricing driven by crypto-currencies?	Science Direct	Dowling, M.	January 2022
Land Valuation in the Metaverse: Location Matters	SSRN	Goldberg, M.; Kugler, P; Schär, F.;	March 2022
Factors Determining the Value of Property: Comparison of Real World and Metaverse	Research Gate	Güven, İ.; Ercan, T.	October 2022

In the first paper, which focuses mainly on The Sandbox, an interesting conclusion shows how willingness to pay is affected by cryptocurrency choice, in particular users who buy in SAND (The Sandbox's native token), pay up to 3.4% more, compared to ETH (Ethereum). (Nakavachara &

Saengchote, 2022)

Another prominent aspect is that metaverse virtual worlds can be considered open economies with no capital controls, no monetary sovereignty, a flexible exchange rate, and a wholly liberal-

ized financial system; consequently, they can be challenging to manage. (Nakavachara & Saengchote, 2022)

Meanwhile, the second paper analyses the pricing of virtual real estate parcels in Decentraland; which represents an example of the growth of NFTs. The results are quite interesting: the pricing behavior of NFT's shows inefficiency in pricing and steady rise in value. That is because, in early-stage markets, market efficiency sluggishly develops only after a volatile search for appropriate pricing models; which they could be also affected by manipulations. for instance, there could be market manipulation in pricing. (Dowling, 2022)

However, as the articles itself states, the study have some limitations; differences between plots of land such as location, nearby amenities, streets and districts, which will be important in pricing, were not considered. (Dowling, 2022)

The third paper analyses the relationship between NFT and cryptocurrency pricing showing, through a spillover index, only limited volatility transmission impacts between NFTs and cryptocurrencies. But also the presence of a co-movement between the two markets has been showed. However, low volatility transmissions could also identify NFTs as a low-correlation asset com-

pared to cryptocur-rencies. (Dowling, 2022)

The analysis also found a modest spillover effect between NFT markets, different from cryptocurrencies and stock markets which have a tendency to have a great spillover; this is probably because NFT markets include different asset classes. (Dowling, 2022)

The fourth and fifth publications found that virtual land location matters, and prices tend to be higher for land in proximity to popular landmarks and for parcels with memorable addresses. (Goldberg, et al., 2021) Accordingly, the importance of location is probably given by activities in close parcels that will attract users interaction. (Güven & Ercan, 2022)

The summarized papers highlight different interesting elements and conclusions about virtual real estate market. However, they are not exhaustive; for instance, the differences between plots of land were not considered, although they would drastically affect pricing. In order to understand more, it is prosed a metaverse real estate reading through a comparison with the real world. It is essential to specify that the analysis developed, just like the papers, only considers the decentralized metaverse.

1.4 Virtual Real Estate vs Physical Real Estate →

2.4 million US dollars – that is the record-breaking price paid for a plot of digital real estate in the Sandbox in 2021. The investment from the company Republic Realm, consisted on the construction of 100 islands, ninety of which were immediately sold for \$15,000 each. (Alkhaldi, 2022)

People are purchasing, building, and using virtual property in creative ways, which is creating **new prospects** for the traditional real estate market in the metaverse, this is possible thanks to blockchain and AR/VR technology. (Deloitte, 2022)

But what does metaverse real estate represent? It represents parcels of **virtual land** which can host commercial, residential and many other typologies of buildings. Users can construct any kind of property on the site, including billboards for advertising, business districts, and the headquarters of real corporations. Metaverse's real estates are programmable environments on various **platforms** where users can interact socially, play games, trade NFTs, market their goods and services, and even participate in business meetings using 3D avatars. (Alkhaldi, 2022)

While the real world is divided in countries, cities and areas, the metaverse is composed by several platforms containing within their map different areas. In these spaces users can buy and sell digital real estate. Nonetheless, platforms should be considered distinct markets since they can be entirely different. To better understand the concept, they could be compared to planets. The four biggest and most popular ones are The Sandbox, Decentraland, Cryptovoxels, and Somnium. The figure shows a portion of The Sandbox map.

Although there is massive growth prediction and profit potential, the metaverse's real estate market is still in its infancy. Furthermore, investments in this sector are somewhat **speculative**. It is not easy to foresee how and to what degree the metaverse phenomenon will have a long-term impact, like what happened with the internet in the 1990s. (Deloitte, 2022) However, real estate sector stakeholders may discover the real potential in the metaverse, especially if they can identify, develop, and successfully test innovative use cases. Nonetheless, to better pre-



Figure 7. | View of a portion of the map of The Sandbox (sandbox.game)

dict and evaluate investments and analyze and forecast trends in the virtual real estate market, it is undoubtedly necessary to have more historical data and, at the same time, more knowledge and understanding. (Abualzolof, 2022) In the physical real estate there is a completely different situation, **historical data** is rich and allow investors to develop accurate evaluations and market predictions. It will take time for the metaverse, to build a good amount of data; until then, investors' experience and intuition will likely guide investments, which at the moment come with barely any **predictability**.

Therefore, at the moment, investing in the metaverse could be riskier and more volatile than with cryptocurrencies; moreover, for many people, the idea of purchasing and selling tokenized assets is still new. Furthermore, factors which do not affect physical real estate properties, such as cybersecurity and potential cyberattacks, should be considered during transactions. Nevertheless, as everything is safely encrypted and protected on blockchains with smart contracts, the likelihood of someone stealing one's virtual property is marginal. However, legal ways to pursue refunds must be better developed and regulated. (Abualzolof, 2022) Another essential

consideration is the security of the crypto wallet, which stores cryptocurrency and NFTs. Wallets are protected by a password or a USB drive (also called Hardware Wallet) that shall not be lost in order to be able to authenticate the ownership of an asset. Many people have lost millions of coins for this reason; that is because no central authority tracks ownerships, which are essentially anonymous except for the owner. (Marr, 2022) (Waterworth, 2022) Hence there is a substantial difference from the real world, where the vast government presence establishes laws concerning ownership rights of properties and their legal recognition. This is done through a formalized system for recording and disclosure that puts others on notice of those rights. (Gordon, 2021) Government policies and legislation, including tax incentives, deductions, and subsidies can boost or hinder demand for physical real estate. (Nguyen, 2021) Even though in the real world a central authority prevents from the lost of an asset, there are of course risks to consider as well, such as natural disasters or illegal occupying of the property.

After proper analysis, it's prudent to say that the metaverse market can still be defined as relatively small and manageable. To better understand this concept, a comparison with the real world can help: in 2021, in the four biggest platforms mentioned before (Sandbox, Decentraland,

Cryptovoxels, and Somnium), virtual land sale transactions were worth more than \$500 million overall. In correlation, Germany alone accounted for € 310 billion' worth of IRL real estate transactions in 2020. (Deloitte, 2022) (PixelPlex, 2022)

Many physical real estate business models, such as selling, renting or flipping, could have excellent profit prospects in the metaverse. Companies looking to develop in specific locations for promotion or a special event are only a few examples of possible renters. Users and architects are free to create their designs or make a virtual replica of an existing building. (Deloitte, 2022) (PixelPlex, 2022)

A Great number of businesses and brands, such as Nike, Zara, Samsung, and Burberry, foresaw in the metaverse a longterm benefit and a great opportunity to leave their mark, not focusing in the current market conditions, as a way to impose their presence in the virtual world. This approach generated great competition and will be an important factor concerning the brand's success. (Guest Op-Ed & Buckler, 2022)

Figure 8. | Nikeland - Nike's City on Roblox platform (Nike)

According to Deloitte: “The ability to succeed with an investment in virtual real estate will greatly depend on the future popularity of the metaverse platforms”; the effect could also be amplified by the volatility of cryptocurrency and by the web 3.0 market trends. Nonetheless, some areas of the metaverse should be foreseen drawing larger virtual crowds than others, depending on their capacity to become popular. Owning a space in one of these trendy virtual communities could attract much attention from potential renters and purchasers and confer substantial status. As a result, the value of the neighbouring properties, including real estate and land, could significantly rise. Undoubtedly, there is a significant risk potential associated with popularity. (Deloitte, 2022)

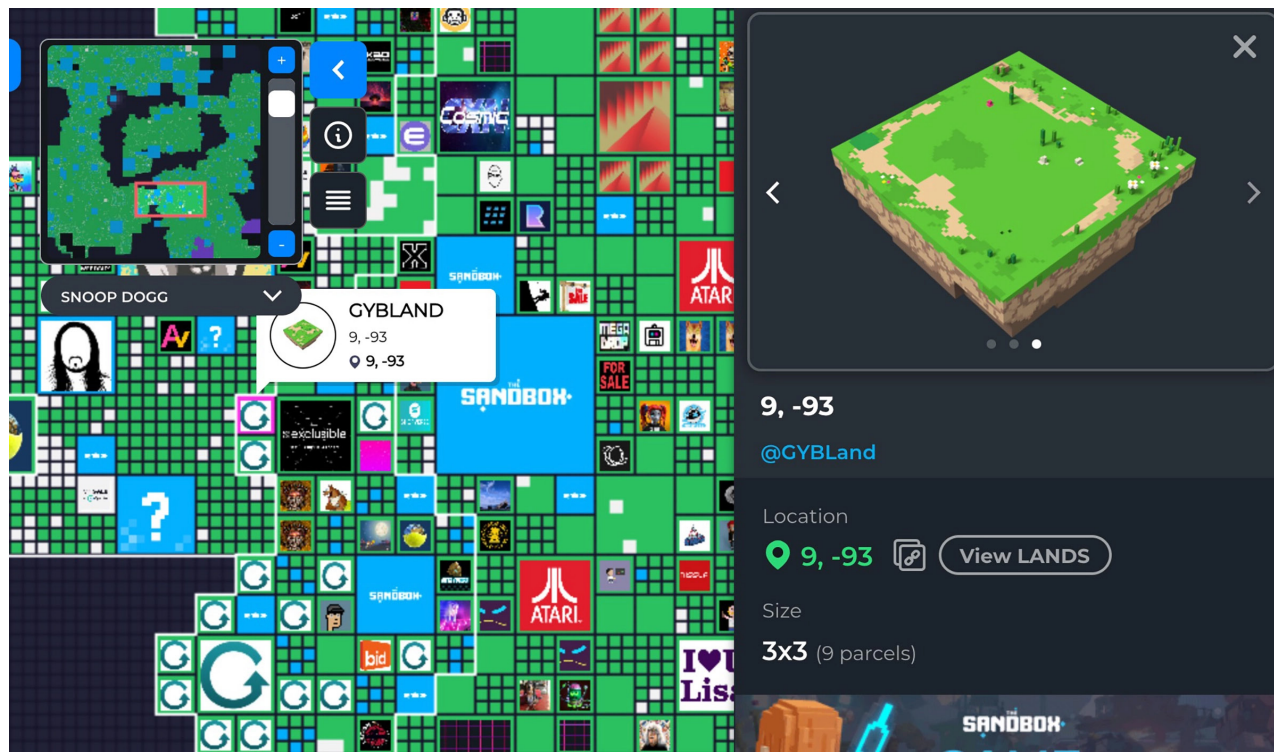
Therefore, **extrinsic characteristics** like **platform** and **location** within the platform will be crucial to make a profitable investment, like in real world properties, where the first rule of real estate is “location, location, location,” according to Harold Samuel. In fact in the real world location is crucial, property close to public transport stations, city center, seaside, prestigious areas and many others can have massive price differences compared to property that don'ts have the same characteristics. That is why it is essential to highlight that in the metaverse avatars may bounce from place to place, except for some platforms such as Somnium Space, where a teletransportation hub is sold separately. Hence journey durations and transportation connections are negligible. (Deloitte, 2022) That said, the value of location is connected to the positions around the property, rather than the travel distance. (Güven & Ercan, 2022) According to the work of (Goldberg, et al., 2021), investors has two different types of locational preferences: property near well-known landmarks and lots with more memorable addresses.

Furthermore, it is essential to focus on **uniqueness** and **immovability** concepts, starting from the real world, where land is precisely unique and immovable by definition. Thus, even two neighbouring lots will have somewhat different



characteristics. In the metaverse, the same holds true. Each parcel has a specific description, different characteristics and a set location that cannot be modified; for in-stance: Decentraland EST #1747 or The Sandbox LAND #47537. However, a building/scene could be moved or rebuilt somewhere else entirely identical (Waterworth, 2022), this highlight a substantial difference from the real world, which undermine an important pillar of physical real estate.

Figure 9. | The Sandbox map view + land overview (The Sandbox)



Focusing on the virtual property, building and managing real estate assets in digital places is fundamentally different from the real world. Certain factors will differ significantly, such as required technical skills and time horizons, risks and tied-up cash due to the lack of liquidity. Nevertheless, from a purely aesthetic and architectural point of view, since the laws of physics do not constrain virtual projects, there are no design limits apart from imagination, and of course plot dimensions and graphics capabilities of the used platform. (Deloitte, 2022) Hence the intrinsic characteristics of the building can be summarized as the architectural design, the dimensions, and the typology, which behave differently from the physical real estate; it can be fluid and change at any moment or even be a mix of several ones. The same space could transform in an instant into a home, gallery, showroom, workplace and more. In addition, physical real estate characteristics such as state of conservation, quality of the finishes, accessibility, floor, natural ventilation and other similar ones lose their meaning in the metaverse.

While the designing part has the potential to be completely different from the real world, the way these spaces (also called scenes) are used is similar. There are many examples where users hosted concerts, developed art galleries, showrooms and many others. For instance, when the

island country of Barbados established a virtual embassy in the metaverse, it made the news. Furthermore, several well-known brands have already started creating virtual experiences in the metaverse. (Deloitte, 2022)

An interesting fact that emerged after analyzing the utility of virtual real estate, is that it is all about fun, social activities, expressing personality and retail. Even the concept of “living” takes meaning in the metaverse; supplying a home where people can have meetings with colleagues or friends, show off NFTs, be citizen of a chosen platform, and much more. (Marr, 2022) While all these activities can be productive and fun, it has to be noted that they are not necessary; on the contrary, in the real world, real estate is vital and undisputable, it consists of places to dine, to practice sports, to breathe, to sleep and much more. Beside this aspect, since the world is finite, the scarcity factor is undeniable, it gives massive value to real estate, properties in locations with little opportunity for expansion are often more expensive than those in areas plenty of space. (Struyk, 2022) Furthermore, it is leading today’s policies to focus on minimizing soil consumption. On the other hand, in the metaverse, supply of land is limited. This is done in order to ensure that digital real estate has value and that social experience is positive; meaning that each metaverse platform only has a certain amount

of lots available, a artificially created scarcity. For instance, Decentraland comprises 90,000 pieces or “parcels” of land, each approximately 50 feet by 50 feet. (Waterworth, 2022) However, there are no rules preventing the platform to add as many plots as they like, thus there is no guaran-tee when it comes to scarcity. (Marr, 2022)

Virtual lands/properties can be sold simultane-ously from the direct chosen platform market-place or third-party resellers, such as opensea.io,

which act as a decentralized real estate portal; further-more, these portals can be compared to real world platforms such as immobiliare.it, Ide-alista, casa.it; nonetheless, an interesting differ-ence stand in the fact that metaverse’s digital marketplaces, do not only sell land, but every kind of NFT. Other portals, such as nonfungible.com, provide market analysis, with real-time transactions monitoring and sales history of any asset or project.

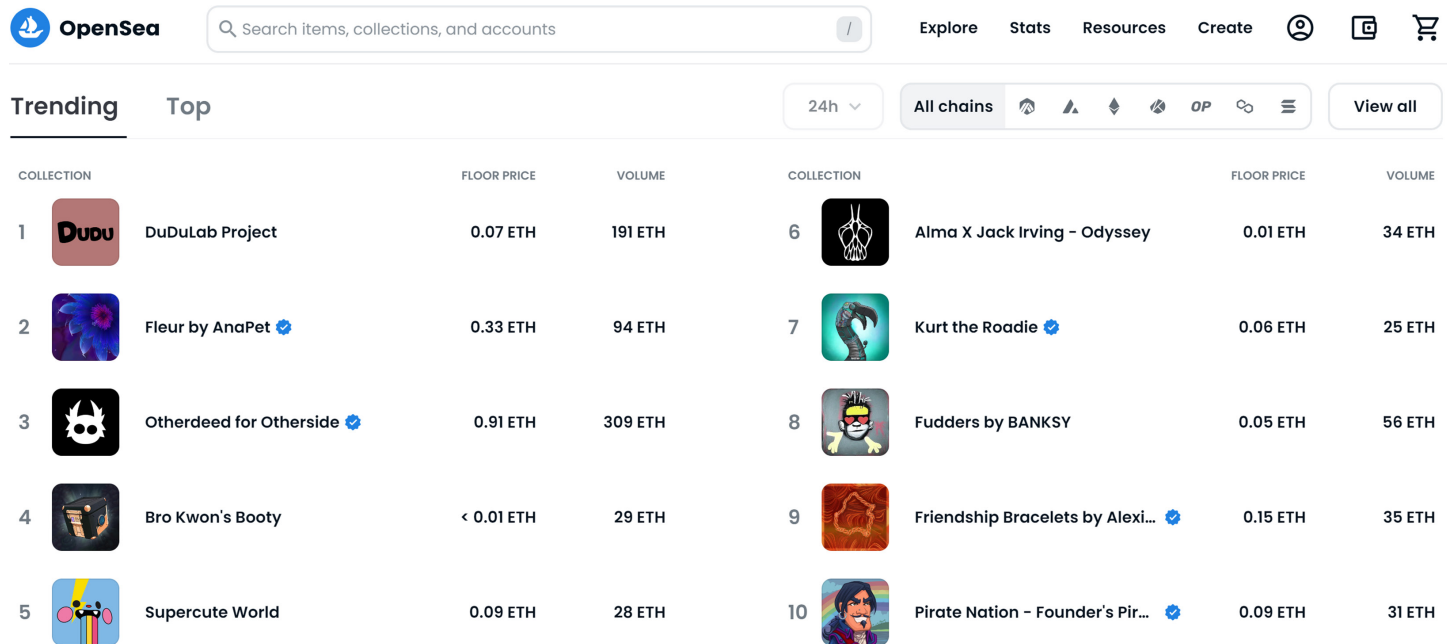


Figure 10. | OpenSea.io - The world’s first and largest digital marketplace for crypto collectibles and NFTs

Even though the **land** is virtual, it is secured with actual acts in the form of **NFTs**. Accordingly, when a transaction is completed, it is recorded on the blockchain, and the related NFT is transferred to the buyer's crypto wallet. Two of the most used ones are Metamask and Binance wallets. Cryptocurrencies allow to handle the purchase; specific platforms provide their own ones. For instance, Decentraland uses MANA, whereas Sandbox trades its native currency, SAND. Occasionally, other cryptos, such as Ethereum, also work. (Waterworth, 2022) (Alkhalidi, 2022) (Marr, 2022)

That said, cryptocurrencies are not only needed to buy undeveloped land. In order to build a

project, there are **production costs** to take into account; however, they are very marginal compared to the real world since construction costs are not present and land prices could be significantly lower. Production costs are mainly technical expenses, such as game developers, architects, and promoter/operator gross profit. Even though urban/permit fees are not present in the metaverse, some processing fees can be up to 5% of the land price. (Alkhalidi, 2022) (Waterworth, 2022) It is necessary to highlight that there is no need for any infrastructure, such as water/sewer lines, fire prevention systems, bathrooms, storage, and others; indeed, there is no danger to public health, at least physically. (Waterworth, 2022)

A summarized comparison table can help to better visualize the differences between physical and virtual real estate. In order to better assess the purpose, Real Estate Market and Real Estate Asset are separated. Three shades of color indicate if the characteristics are different, similar or practically the same.

Same characteristics
Similar
Different

	Real Estate Market	
Dimension of analysis	Physical Real Estate	Metaverse Virtual Real Estate
Economic players	Mainly, the subjects involved in economic activities are the investor and the consumer , depending on the behavioural model they assume in economic activities. Players can be : Private, Institutional, Funds, Companies, Government	The involved economic players are the same except for some exceptions, like the Government. There are investors and consumers such as: user-owner, real estate agency, real estate fund, real estate company.
Intermediation figures	There are intermediation figures needed such as Notary, and there are others which are facultative like Real Estate Agency.	There is no need for intermediation figures thanks to the blockchain. However, some real estate agencies are already present.
Multidimensional use nature	Multidimensional use nature: consumer good and capital good	Multidimensional use nature: consumer good and capital good
Purchase as investment	The purchase of a property guarantees a flow of future income. Only economic purposes influences investors' choice, depending on their income, the real property characteristics and its profitability with respect to alternative investments in the market. The real property is considered a capital good	Metaverse land can be improved and sold or rented. Thus it can be an investment and so considered a capital good .

Dimension of analysis	Physical Real Estate	Metaverse Virtual Real Estate
Purchase as self-consumption	Benefits are derived from direct use of the building, or the asset is instrumental to production. Economic and financial profiles influence the behaviour of the economic player. The real property is considered a consumer good	The self-consumption differs in the fact that virtual real estate is not a need but an entertainment. Thus the consumer good is considered in a different way.
Immovability concept	Immovability of buildings and land, which leads to limited stock but unlimited duration -> urban rent	Each virtual parcel is described uniquely and is located in a fixed place. However, a building (also called a scene) could be moved or rebuilt somewhere else completely identical. The land could have a limited duration since the platform could close.
Scarcity concept	Limited amount of Land, since the world is finite.	Plot quantity could be increased since scarcity is created on purpose.
Market dimensions	Space dimension of the local market: evaluation of the property may take into consideration a local market very limited in space -> fixity location effect	The properties are limited in the single platform due to the scarcity created. The duration can be limited because is related to the platform, which might close in the future.
Market segmentation	The Real Estate Market can be disaggregated into different submarkets that are distinguishable through factors that determine the demand curve and supply curve. The price formation mechanisms (demand and supply) of each Market segmentations are determined by a hierarchy of factors, the most important of which are generally location and destination .	There are various platforms containing within their map different areas. Nonetheless, platforms could be compared to planets since they can be totally different. Consequently, location and destination are crucial factors in the price formation mechanism.
Supply and demand trends	Cyclical trend -Supply is rigid and less reactive with respect to Demand. Thus supply is subordinated to demand, hence no market equilibrium.	Metaverse is still in its infancy, and there is almost no historical data, which makes forecasting trends in the virtual real estate market very difficult.
Central market	There is no central market for properties. Buyers and sellers are brought together through real estate agents and through various communication channels, such as Immobiliare.it	Virtual real estate (Land/scene) can be bought through the platform itself or from other virtual markets, such as opensea.io.

Dimension of analysis	Physical Real Estate	Metaverse Virtual Real Estate
Market regulation	The vast government presence establishes laws concerning ownership rights of properties and their legal recognition. This is done through a formalized system for recording and disclosure that puts others on notice of those rights.	The market is decentralized thanks to the web 3.0 technology. It will probably be more regulated in the future. Currently there are no regulations or restrictions.
Market stability	The value of physical real estate will always be present thanks to the stability of the market, which can have a quite good grade of predictability.	The market value is highly volatile, and it can be affected by the platform's popularity, cryptocurrency value, or even the whole web 3.0 market trends. Consequently it is present a lack of predictability.
Market registry	In physical real estate there is a central authority, the Government, which handles all the data and back them up in a registry.	There's a title for each individual parcel of land, which is recorded in a registry, and the owner gets a copy to prove their ownership. However, only the owner can decrypt the data and because of the decentralisation, no central authority can recover it.
Transparency	In some countries, the real estate registry does not exist or is inefficient. Consequently, ownership of physical and digital assets is usually challenging to track.	The decentralisation allows transparency: Ownership is authenticated and protected through NFTs, which are immutable and allow to establish the "provenance" of the assigned NFT, proving the creator and all property details, as well as accurate ownership records, on the blockchain.
Transaction	A significant amount of capital is usually needed in order to buy a real plot. The buying process can take months, mainly because it needs third parties, such as a notary.	Prices are still affordable for virtual lands, and the buying process can be done within minutes. The purchase of a piece of digital real estate is recorded on the blockchain, and the land/building, which is an NFT, is transferred to the buyer's digital wallet.

Table 1. | Physical vs Virtual Real Estate Market Comparison (own elaboration)

	Real Estate Asset	
Dimension of analysis	Physical Real Estate	Metaverse Virtual Real Estate
Construction costs	Construction costs are usually a massive amount of money.	There are no construction costs in the metaverse since it's everything virtual.
Production costs	It's formed by the summatory of the construction cost, total urban fees and fees for permits, technical expenses, passive interests, general expenses and promoter / operator gross profit.	Production costs are very marginal since construction costs are not present. The production costs can be listed as technical expenses (game developer and architect) and promoter / operator gross profit. There are no urban/permits fees.
Taxes	Different taxes and fees to pay, such as capital gains.	Tax benefits and no capital gains
Depreciation	Depreciation occurs over the years, consequently, there are also significant maintenance costs	There is no depreciation and no maintenance costs at the moment
Extrinsic characteristics	Location with respect to the center of a city, Accessibility Public transport and connections, Supply of services, Private services (shop), Environmental quality, Socio-economic features	Location is one of the most crucial characteristics, and it can change values based on more popular areas. Many variables are not present, such as public transportation, since the user can jump from one place to another.
Intrinsic characteristics	Position: positioning, view, light, floor, natural ventilation Typology: size, age, architecture, Physical and economic decay, windows, secondary areas, potential for changes, lift, technical equipment Functional / economic: Limitation to property rights, seller, payment, free/occupied, Technical equipment, quality of common areas.	Position: Every parcel has a different height limit according to its dimensions. More lands allow for building higher. Land positioning can have some variables based on the surroundings. The typology is reduced to the architectural design and function of the building, which can be fluid and change at any moment or even be a mix of several. Characteristics like the state of conservation, the quality of the finishes, accessibility, floor, natural ventilation and other similar ones lose their meaning. Functional/economic: A land/scene can be rented.
Real estate typologies	Land, Residential, retail, offices, industries, logistics, rural, special, public.	Land, Residential, Retail, Museums, Art Galleries, Markets and many others.

Table 2. | Physical vs Virtual Real Estate Asset Comparison (own elaboration)

To summarize, there are benefits and drawbacks in both physical and virtual real estate.

Physical real estate has different advantages, such as control, stability, and liquidation potential; however there are drawbacks, like high start-up capital, slow transaction time, long term commitment.

Meanwhile virtual real estate advantages are affordability, tax benefits, zero regulations or restrictions, quick transaction, no intermediaries, and profitability. Nonetheless, its downsides are quite significant: lack of liquidity, limited historical data, extremely volatile and absence of a central authority to record ownerships.

Before showing the market value analysis it is essential to put in context some numbers and data about metaverse market and most important platforms.

1.5 Market Trends →

As introduced, a large number of companies already put their trust in the metaverse; in fact, Accenture's survey displays that 71% of global executives believe that metaverse will be a benefit for their business in the long term. The predictions are optimistic, the market size is expected to experience a substantial growth between 2022 and 2030, reaching 1.5 trillion. (Alkhalidi, 2022)

Between January and May 2022, we already witnessed a significant increment: the amount invested in metaverse by venture capitalists, corporations, and private equity doubled the

correspondent one relative to 2021, reaching \$120 billion. (CNN, 2022)

Despite this data, after May 2022 the market took a huge fall as real estate values and land prices fell 50 to 80% in the main metaverse platforms (The Sandbox, Decentraland, Cryptovoxels and Somnium Space). In fact NFT sales in the metaverse are modest if compared to the total NFT industry, counting 53,000 sales for \$365 million traded. (Alkhalidi, 2022)

Global metaverse market size

(\$, in billion)

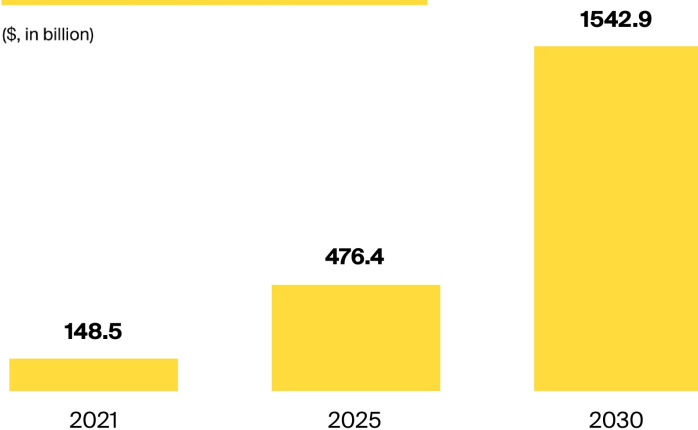


Figure 11. | Global metaverse market size prediction (Alkhalidi, 2022)

NFT sales volume for Q1 2022

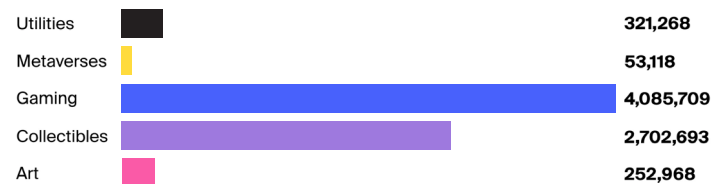


Figure 12. | NFT sales numbers for Q1 2022 (Alkhalidi, 2022) (NonFungible.com, 2022)

While media speculate about a great fall of metaverse, the Quarterly NFT Market Report states just the opposite. In fact, as volumes fell down, the prices have risen up, showing that the NFTs in circulation circulate are, on the contrary, true assets. (NonFungible.com, 2022)

Despite ups and downs, metaverse is considered by the majority of stakeholders as a long term investment and its future, according to Deloitte, could rely on four main factors. Firstly is necessary to focus on standardization and whether this technology will reach an unified economy across different metaverse platforms. Market segmentation is important as well: will platforms compete with each other or serve different markets? The third factor is the user interface and seamless user experience. And the last one regards the possibility for the government to assure the safety of transactions issuing regulations. (Alkhalidi, 2022)

The previously cited most common platforms - The Sandbox, Decentraland, Cryptovoxels, and Somnium Space - are introduced in order to give a general overview before showing the land price analysis. All four runs in the Ethereum blockchain. In total they count 268,645 parcels of virtual land

in different size. Thanks to the sales graph made by (Alkhalidi, 2022) is possible to compare the sales across the different platforms in the same timeline.

The Sandbox

Celebrities are particularly a fan of The Sandbox. In fact, what makes it valuable are the users, which can count many influential people, including Paris Hilton and Snoop Dogg. (Alkhaldi, 2022) There is also a huge variety of major brands and companies such as Adidas, Binance, South China Morning Post, Atari and many others. (Nakavachara & Saengchote, 2022)

It counts 166,464 LANDs (408 × 408) in its map (Nakavachara & Saengchote, 2022) and owns approximately 62% of the whole market. It also

has its own cryptocurrency: SAND. (Alkhaldi, 2022)

The Sandbox has a gamification focus. It allows users to have the resources they need to make their own games through three tools: Voxedit, a 3D voxel modelling and NFT creation application which allows users to construct and animate objects and game assets; Marketplace, a place to up-load and sell users' creations; Game Maker, which helps developing games for free. (Alkhaldi, 2022)

(April 16 – May 16, 2022)

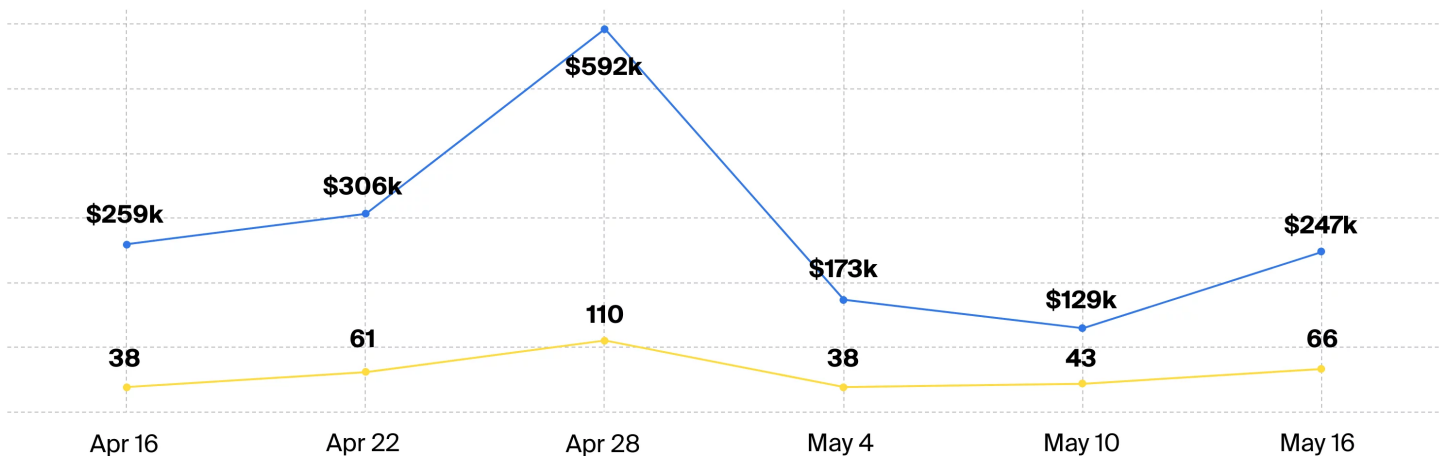


Figure 13. | The Sandbox: number of sales and sales volume (Alkhaldi, 2022)

Voxel (ex Cryptovoxels)

Since gaining notoriety in 2018, Voxels has continuously strived to create and implement new features. It has advanced and established a more robust market presence over time in the metaverse. Voxel has 6,554 virtual lands. The platform visually looks like a mix of Minecraft and Facebook. Users can build blocks and customize the design under the voxel art aesthetic, which has a cubic or pixelated form. (Alkhalidi, 2022)

(April 16 – May 16, 2022)

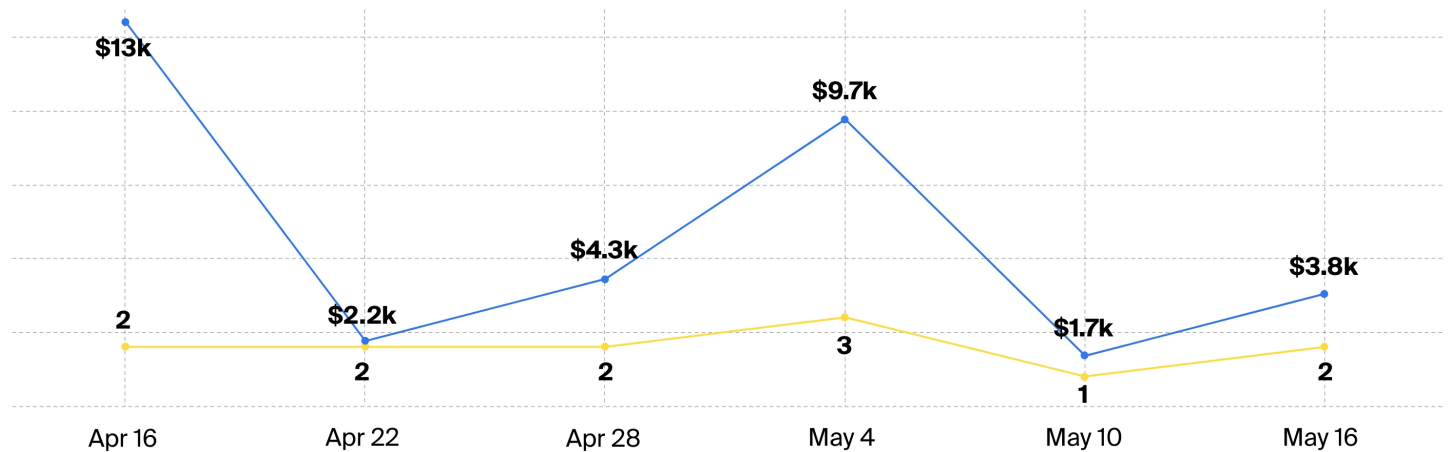


Figure 14. | Voxel: number of sales and sales volume (Alkhalidi, 2022)

Somnium Space

Somnium Space is divided in 5 026 parcels, which can have different sizes: small, medium and extra-large. The platform also offers a software development kit to help users with avatar and property creation. An essential aspect to highlight is the travelling experience: users can teleport only if the property owner has bought and installed a teletransportation hub. (Alkhaldi, 2022)

(April 16 – May 16, 2022)

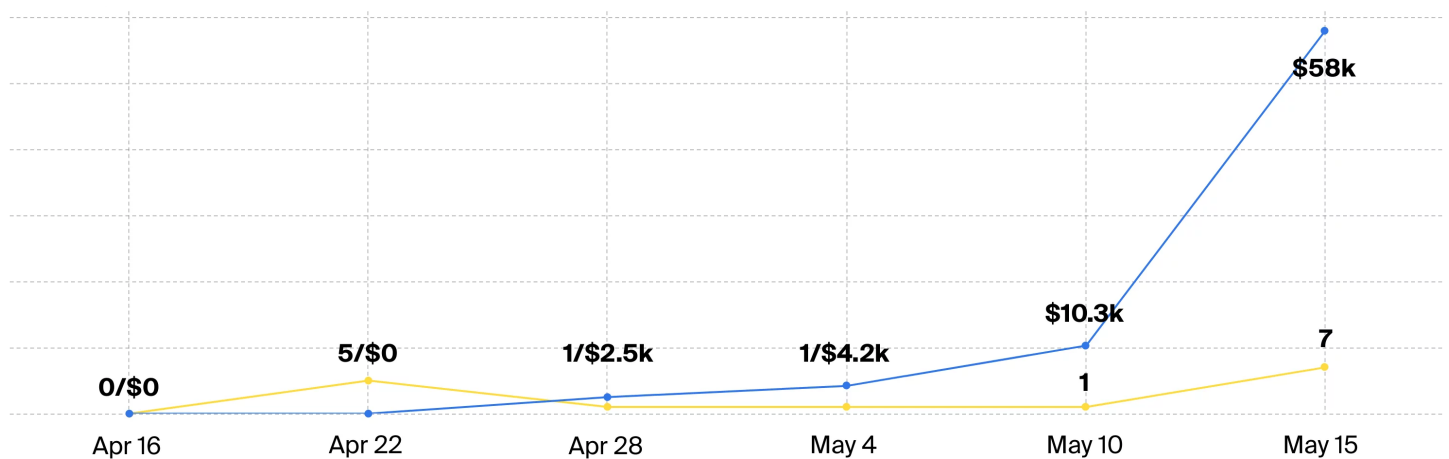


Figure 15. | Somnium Space: number of sales and sales volume (Alkhaldi, 2022)

Decentraland

Decentraland counts 90,601 plots of land of 16x16 meters. The map, which has a well-established infrastructure, has 43,689 private lands, 33,886 districts, 9,438 parcels for roads and 3,588 plots for plazas. The platform is totally user-owned, allowing people to build avatars, scenes and marketplaces. It also offers its own coin, MANA. (Alkhalidi, 2022)

There are two ways to produce digital content: A visual tool called The Builder uses drag and drop with mainly pre-made objects, including interac-

tive ones that respond to player input. Additionally, it is possible to import unique models; and the SDK, which enables coding, which provides a ton of versatility for building items and scenes. (Alkhalidi, 2022)

(April 16 – May 16, 2022)

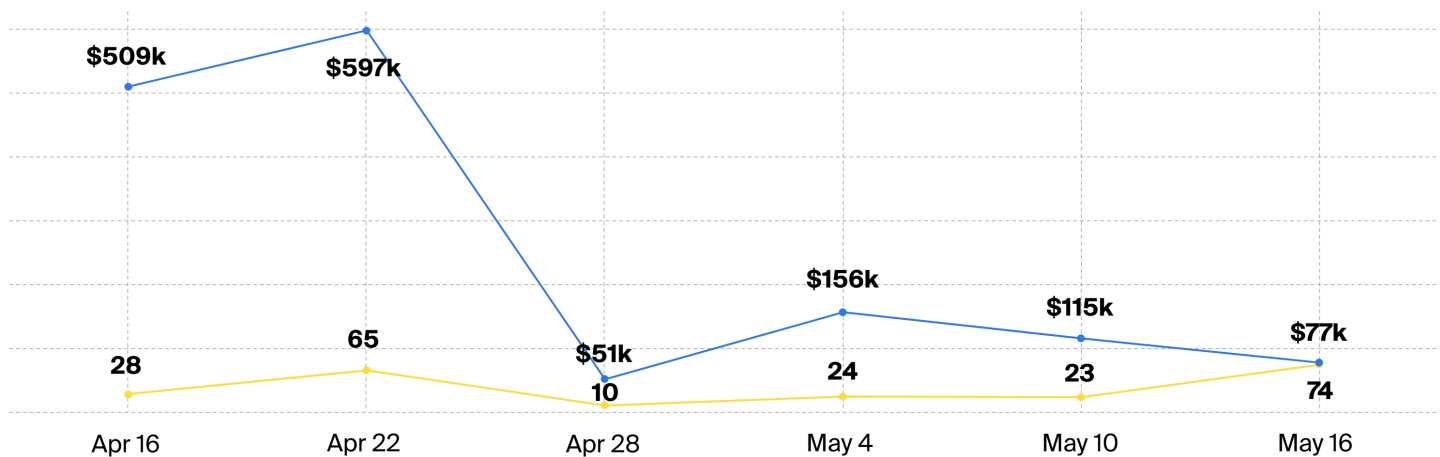


Figure 16. | Decentraland: number of sales and sales volume (Alkhalidi, 2022)

3



Market value in the Metaverse

To address the objective of this research, it is necessary to understand if the three conventional appraisal methods for estimating the market value of real estate, Market Comparison Approach, Income Approach and Cost Approach; could be applied to virtual real estate evaluations.

The Cost Approach is not suitable for estimating virtual real estate well because, in the metaverse, construction costs and land prices are very marginal, and there is no depreciation. Likewise, for the Income Approach, which is very complicated to calculate in virtual worlds since the value can vary massively based on the brand/building. Consequently, the analysis will focus on and implement the **Market Comparison Approach**.

In order to have a consistent and reliable analysis, the choice of a platform was necessary; ac-

cord-ingly Decentraland market has been considered for the study.

Based on the characteristics of Decentraland, the data used to evaluate the market value were five: **Land price**, which has been reported in its original coin, and distances from **Plaza, Road** and **District**, considered on a scale from 0 to 9 (parcels). Parcels with distances exceeding nine do not display such parameters on their overview page. However, virtual lands with longer distances were considered with a value of 10 since each parameter needs to be established to perform the chosen analysis. Even though distances could be manually calculated, it was not necessary because they are not considered from a transportation point of view but from proximity to important/populated places.

Table 3. | Land recent purchases
(own elaboration)

N°	Parcel coordinates	Selling price	Lands	Unit price	Unit price €	Distance from		
						Road	Plaza	Distric
1	10,61 -106,-4 -106,-5	4.850 MANA	1	4.850 MANA	1.935 €	11	11	0
2	-105,-5 -104,-4 -104,-5	27.000 MANA	6	4.500 MANA	1.795 €	11	11	0
3	107,-135	3.939 MANA	1	3.939 MANA	1.571 €	11	11	0
4		3.900 MANA	1	3.900 MANA	1.556 €	1	11	11
5	18,-119	4.999 MANA	1	4.999 MANA	1.994 €	1	11	11
6	113,130	3.969 MANA	1	3.969 MANA	1.583 €	11	11	0
7	25,-83	5.000 MANA	1	5.000 MANA	1.995 €	0	11	11
8	41,-65	4.488 MANA	1	4.488 MANA	1.790 €	5	11	11
9	120,-100	1,35 ETH	1	1,35 ETH	1.654 €	11	11	0
10	24,88	1,50 ETH	1	1,50 ETH	1.838 €	4	11	0
11	89,-129	4.300 MANA	1	4.300 MANA	1.715 €	11	11	0
12	35,21	4.069 MANA	1	4.069 MANA	1.623 €	11	11	11
13	113,-130 -113,5 -113,4 -113,3 -112,5	3.969 MANA	1	3.969 MANA	1.583 €	11	11	0
14	-112,4 -112,3 -11,5 -111,4 -111,3	44.420 MANA	9	4.936 MANA	1.969 €	2	11	0
15	114,-130	3.988 MANA	1	3.988 MANA	1.591 €	11	11	0
16	-118,6 -117,6	9.500 MANA	2	4.750 MANA	1.895 €	5	11	0
17	116,,125 -118,7	3.950 MANA	1	3.950 MANA	1.576 €	11	11	0
18	-117,7 -116,7	13.888 MANA	3	4.629 MANA	1.847 €	6	11	0
19	-114,8	4.250 MANA	1	4.250 MANA	1.695 €	7	11	0

N°	Parcel coordinates	Selling price	Lands	Unit price	Unit price €	Distance from		
						Road	Plaza	Distric
20	118,-101	38.888 MANA	9	4.321 MANA	1.724 €	11	11	0
	118,-102							
	118,-103							
	119,-101							
	119,-102							
	119,-103							
	120,-101							
120,-102								
120,-103								
21	116,-125	4.450 MANA	1	4.450 MANA	1.775 €	11	11	0
22	96,-105	7.999 MANA	2	4.000 MANA	1.596 €	11	11	0
	97,-105							
23	-118,29	4.888 MANA	1	4.888 MANA	1.950 €	1	11	11
24	-118,-49	4.250 MANA	1	4.250 MANA	1.695 €	0	11	11
25	-120,-45	10.888 MANA	2	5.444 MANA	2.172 €	0	11	11
	-119,-45							
26	-122,-45	5.000 MANA	1	5.000 MANA	1.995 €	0	11	11
27	-123,3	8.500 MANA	2	4.250 MANA	1.695 €	2	11	0
	-122,3							
28	123,-9	1,55 ETH	1	1,55 ETH	1.899 €	8	11	0
29	124,-118	1,55 ETH	1	1,55 ETH	1.899 €	11	11	0
30	-124,5	38.420 MANA	8	4.803 MANA	1.916 €	3	11	0
	-124,4							
	-123,5							
	-123,4							
	-122,5							
	-122,4							
	-121,5							
-121,4								
31	54,-136	1,50 ETH	1	1,50 ETH	1.838 €	11	11	11
32	125,-101	4.000 MANA	1	4.000 MANA	1.596 €	11	11	0
33	-125,-83	5.888 MANA	1	5.888 MANA	2.349 €	0	11	11
	-126,19							
34	-125,19	19.500 MANA	3	6.500 MANA	2.593 €	0	11	0
	-124,19							

N°	Parcel coordinates	Selling price	Lands	Unit price	Unit price €	Distance from		
						Road	Plaza	Distric
35	-127,-83	4.169 MANA	1	4.169 MANA	1.663 €	2	11	11
36	-130,-67	5.888 MANA	1	5.888 MANA	2.349 €	0	11	11
37	133,-98	1,60 ETH	1	1,60 ETH	1.960 €	11	11	0
38	143,-17	3.950 MANA	1	3.950 MANA	1.576 €	6	1	11
39	145,-23	4.999 MANA	1	4.999 MANA	1.994 €	4	11	11
40	147,-58	5.999 MANA	1	5.999 MANA	2.393 €	2	11	8
41	-27,-143	3.975 MANA	1	3.975 MANA	1.586 €	1	11	11
42	-31,88	1,30 ETH	1	1,3000 ETH	1.593 €	4	11	6
43	-31,89	1,30 WETH	1	1,30 WETH	1.594 €	3	11	5
44	-31,90	5.120 MANA	1	5.120 MANA	2.043 €	2	11	4
45	37,-62	4.350 MANA	1	4.350 MANA	1.735 €	2	11	11
46	38,-77	1,47 ETH	1	1,4650 ETH	1.795 €	3	11	11
47	-39,146	3.988 MANA	1	3.988 MANA	1.591 €	6	11	8
48	-4,48	4.105 MANA	1	4.105 MANA	1.638 €	1	11	3
49	-41,-13	4.385 MANA	1	4.385 MANA	1.749 €	8	11	11
50	41,-66	1,44 ETH	1	1,44 ETH	1.764 €	5	11	11
51	-42,-13	4.488 MANA	1	4.488 MANA	1.790 €	7	11	11
52	44,101	3.360 MANA	1	3.360 MANA	1.340 €	8	11	5
53	-44,-13	4.688 MANA	1	4.688 MANA	1.870 €	5	11	11
54	-50,81	3.815 MANA	1	3.815 MANA	1.522 €	2	9	0
55	56,-48	2,00 ETH	1	2,00 ETH	2.451 €	3	1	11
56	57,-48	6.250 MANA	1	6.250 MANA	2.493 €	1	3	11
57	-58,-112	4.144 MANA	1	4.144 MANA	1.653 €	2	11	11
58	-70,125	4.999 MANA	1	4.999 MANA	1.994 €	0	11	3
59	-71,-107 -70,-107	7.888 MANA	2	3.944 MANA	1.573 €	11	11	11
60	-73,41	5.980 MANA	1	5.980 MANA	2.386 €	8	11	2
61	78,-100	3.925 MANA	1	3.925 MANA	1.566 €	11	11	0
62	-9,-140	5.685 MANA	1	5.685 MANA	2.268 €	0	6	11
63	90,-110 90,-111	7.869 MANA	2	3.935 MANA	1.570 €	11	11	0
64	91,-110	3.975 MANA	1	3.975 MANA	1.586 €	11	11	0
65	91,-111	3.925 MANA	1	3.925 MANA	1.566 €	11	11	0

Along with what emerged from Goldberg et. al. work, the importance of location is given by the shortest distance from Plaza, Road and District. (Goldberg, et al., 2021) That is why, to properly assess the market value evaluation, a mathematical method was set: the linear regression, which, in this case of real estate, takes the name of Hedonic Regression.

It consists basically of a regression model used to calculate the impact of several variables on a good's pricing or, occasionally, demand. The price of the product is the dependent variable, and the independent variables are the characteristics of the good that may affect the value. The weights buyers assign to the different features of the good may be assumed from the estimated coefficients that arise on the independent variables. (Investopedia, 2021)

"In order for regression results to be properly interpreted, several assumptions about the data and the model itself must hold." (Beers, 2022) That it's why some outliers cases were not considered and removed from the table; for instance some lands which sold at a much more higher price for popularity or other reasons.

In this case of regression the unit price is dependent variable and the Plaza, Road, and District are independent variables. Based on the regression results the intercept coefficient shows that expected unit price will be still 2.354 euros even if all other variables (Plaza, Road, and District) are equal to zero.

The following graphs show the relation between the price and every single variable. The table below shows at the same time the results of the linear regression model.

District	Plaza	Road	Price
-4,83	-31,21	-31,21	2.354,24 €

Table 4. | Linear Regression Results

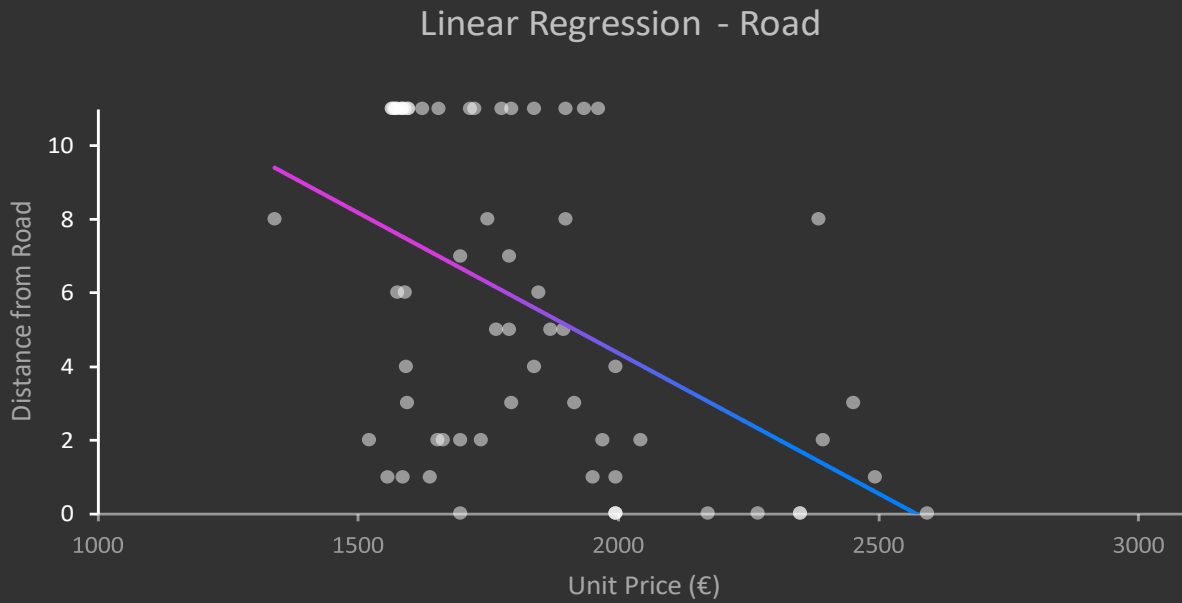


Figure 17. | Linear Regression Graph - Road (own elaboration)

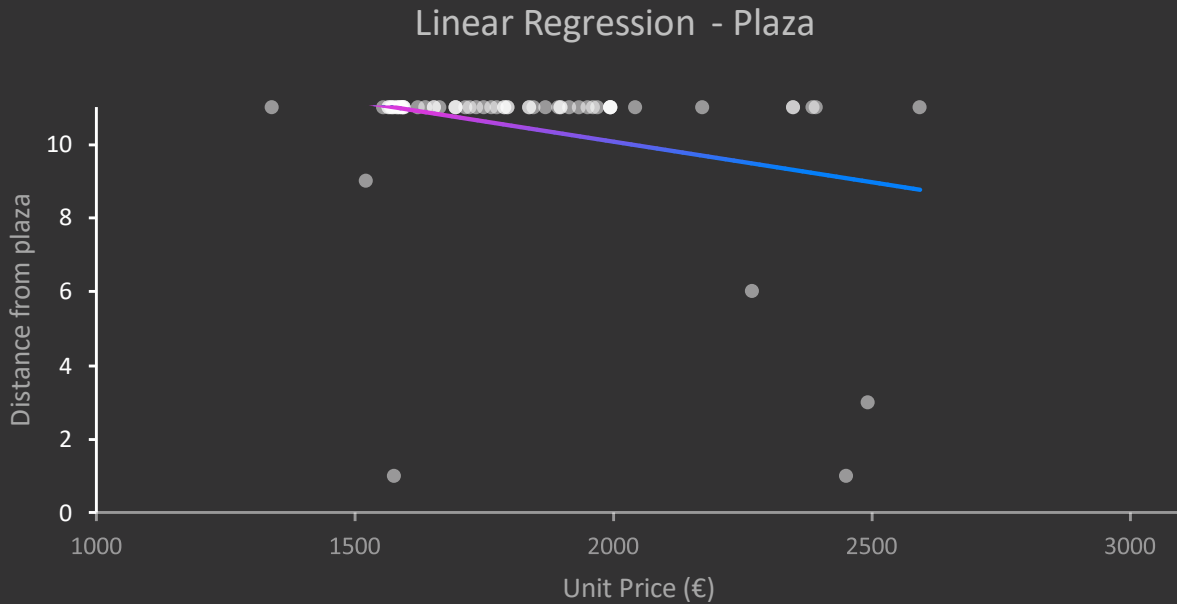


Figure 18. | Linear Regression Graph - Plaza (own elaboration)

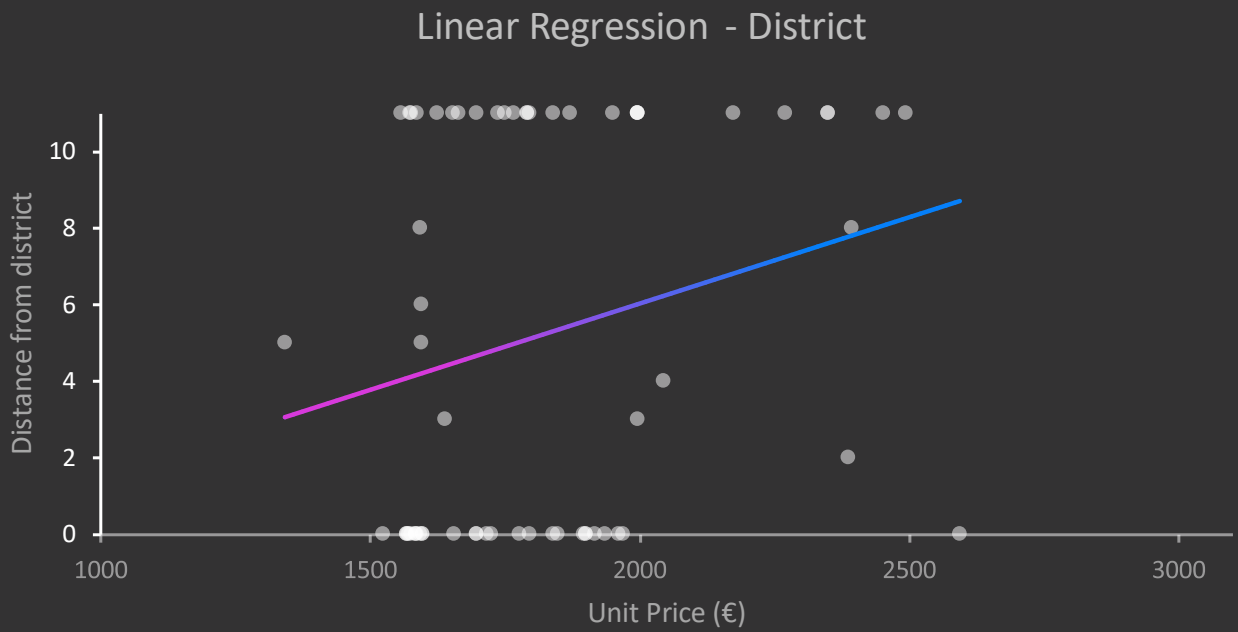


Figure 19. | Linear Regression Graph - District (own elaboration)

While the first two may give an idea of how the price increases for parcels closer to roads and plazas, the third graph does not represent reality. The district is one of the most essential variables. That said, there are many districts, each one different from the others, with different rules and prices.

The graphs and the results show the limitations of this work and especially that in order to properly assess the market value, a much bigger and deeper economic analysis that could consider many more variables would be required. Therefore this research could open possibilities for future studies inspired to perform a much more complex regression model.

Conclusions

The world is at the dawn of a new era, the virtual reality may become part of our lives. The concept of the metaverse already evolved from its game concept, and it is touching many areas. Nonetheless, the building of virtual environments still carries different challenges that still need to be re-solved.

The research aims to shed a light on a sector with considerable investment potential. It does so through an indepth analysis carried out with a key to a comparison with the real world and an evaluation of the market value, in order to understand virtual land throughout physical land.

The work shows various differences and shades between the two realities, but they travel on parallel worlds. Although teletransportation, location remains, like in physical real estate, one of the major incident factors, and utility is not far behind.

The final market value analysis shows that there are many factors that influence the price, and a simple linear regression model is not sufficient to find a mathematical correlation. That said, this work may lead to future deeper studies and insights, for a virtual world which will have endless possibilities.

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Endnotes

1 Meta Platforms, inc. (ex. Facebook, inc.)

2 <https://spatial.io/>

3 Ledger: "A cryptocurrency public ledger is a record-keeping system. The ledger maintains participants' identities anonymously, their respective cryptocurrency balances, and a record of all the genuine transactions executed between network participants." - investopedia.com

