

Shopping Experiences in the Metaverse

# Implementation of a white lable Metaverse Solution

# Abstract

With the use of virtual worlds becoming a growing trend, the metaverse is becoming a promising channel for Brands to offer their customers immersive shopping experiences . While many brands are interested in utilising this new channel, creating them comes with several challenges and uncertainties as many companies lack experience within this field . This thesis tries to shed light on the process associated with building a virtual shopping experience by following the process of developing a white-label shopping mall solution . The resulting solution was successfully launched and was able to attract eight customers who leased a store .

Keywords: ['virtual', 'metaverse', 'store', 'channel']

Polarity: Neutral (0.18)

Subjectivity: 0.41 / 1.0

# Introduction

The term “metaverse” has reached mainstream audiences and has had a polarising effect on consumers and businesses alike . While consumers seem to be confused by the concept, others interpret current metaverse developments as a mere fad at best and see it as the newest marketing buzzword . While looking at various use cases, this thesis will mainly explore the metaverses' potential as a platform for creating immersive shopping and advertising experiences . This thesis will analyse the current state of this field of study and show how metaverse shopping experiences can be implemented .

Keywords: ['metaverse', 'term', 'consumers', 'businesses']

Polarity: Neutral (0.06)

Subjectivity: 0.44 / 1.0

## Objectives and Scientific Approach

With the emergence of the metaverse as a new digital channel, more and more companies are looking at ways to take their brands into the Metaverse . This thesis will explore how companies can leverage metaverse platforms to create 3D shopping spaces and experiences for consumers . The research question will be examined from both a theoretical as well a practical point of view . The literature review will be followed by the main part, which will follow the implementation of a white-label metaverse solution at the company Worldline .

Keywords: ['metaverse', 'experiences', 'review', 'solution']

Polarity: Neutral (0.1)

Subjectivity: 0.33 / 1.0

# Literature Review

This literature review will examine some of the basic questions such as what the metaverse is, how it works, as well as the type of applications it can be used for . With these basics covered, the review will focus on the shopping/commerce use case . This section will end by reviewing several options for developing on metaverse platforms and going through key concepts related to the development of virtual worlds . The review will also examine the role of the Metaverse as a sales channel and determine which factors influence the consumer’s experience .

Keywords: ['metaverse', 'review', 'key', 'concepts']

Polarity: Neutral (0.04)

Subjectivity: 0.41 / 1.0

## The Metaverse

Metaverse is a three-dimensional virtual world, in which users are able to interact with each other . The development of virtual spaces and worlds can be traced back to the 1970s and has been heavily influenced by the gaming industry as well as various works of science fiction . It is now believed that all major industries such as “health care, consumer products, entertainment and business-to-business technical solutions to payments” will in some way be influenced by the metaverse . The domain of virtual commerce has been at the forefront of the commercialization of virtual worlds .

Keywords: ['metaverse', 'virtual', 'world', 'platforms']

Polarity: Neutral (0.08)

Subjectivity: 0.37 / 1.0

## What is the Metaverse?

Academic literature currently does not offer an agreed upon definition of what a metaverse is . While the metaverse remains undefined, the number of competing definitions i growing quickly . Finding a suitable definition has been the main topic of numerous metaverse research papers . Table 1 showcases five metaverse definitions from research papers used as part of this literature review . Virtual worlds are defined by ‘persistent online computer-generated environments where multiple users in remote physical locations can interact in real-time for the purposes of work or play’

Keywords: ['metaverse', 'virtual', 'worlds', 'definition']

Polarity: Neutral (0.09)

Subjectivity: 0.35 / 1.0

## Metaverse building blocks

Current research tries to establish an architecture for the metaverse, which has resulted in the creation of several models that try to organise individual building blocks logically . This section will review approaches found in current research and evaluate how these compare to each other . Additionally, some of the core technologies will be highlighted to clarify their application within the metaverses technology stack . The technology stack is rather complex, with the technology stack, on which the Metaverse is built, rather than an exact definition of the future is yet to be established .

Keywords: ['metaverse', 'innovations', 'technology', 'stack']

Polarity: Neutral (0.01)

Subjectivity: 0.31 / 1.0

## Metaverse Architecture

Various research papers try to organise technological, as well as non-technological dimensions, into a single structure . Lee et al. organise these factors into 14 focus areas that will support the creation and usage of the metaverse . The proposed structure defines a technology and ecosystem layer, which groups elements, starting with fundamental building blocks such as infrastructure and avatars . Other researchers have opted for similar layered approaches but have put less emphasis on the concrete technologies that these layers contain . This approach focuses on the convergence of the physical and virtual world, with the infrastructure layer containing components that are purely physical or digital .

Keywords: ['metaverse', 'model', 'layer', 'ecosystem']

Polarity: Neutral (0.11)

Subjectivity: 0.38 / 1.0

## Metaverse Technologies

As the metaverse will be a (or many) virtual world(s) at its core, game engines are an essential part of the creation process. Basic features include graphics rendering, physics engines, lighting systems and collision detection, which are required for almost any virtual world. While big game developers typically build their own in-house game engines, the majority of today’s video games are developed on pre-built engines. The market for such pre-built solutions is dominated by the open-source solution Unity, developed by Unity Technologies and the Unreal engine by Epic Games . Virtual and Augmented Reality: Virtual reality (VR) and augmented reality (AR) are believed to be the primary interface through which users experience the metaverse . In the case of VR, the user is blocked off from the outside world and fully immersed inside the virtual space. AR, on the other hand, overlays virtual assets onto the physical world, letting the user experience the real world through a see-through display. To give users the impression of full immersion, VR headsets have to mimic the human visual range, which requires a FOV of 200° x 130°. While current displays can get close to this visual range, it requires the use of displays with at least 6K horizontal resolution, making such headsets extremely expensive . Additionally, there is the problem of motion sickness, which is a phenomenon many users experience while using VR headsets that causes feelings of nausea and dizziness. This data structure is stored on all nodes participating in the blockchain network, making the network completely decentralised. Additionally, a new block can only be added through a so-called consensus algorithm, which forces all nodes to agree on the validity of a newly added block . In combination, these techniques lead to a system that is almost impossible to manipulate or control, while remaining completely decentralised . Decentraland has even gone a step further and created a Decentralised Autonomous Organization (DAO) through the use of smart contracts. This organisation votes on issues including land and estate features, marketplace fees etc., which all community members can participate in . Artificial Intelligence: Artificial Intelligence (AI) is an umbrella term for all technologies “that enable machines to learn, think and behave like humans do” . State-of-the-art AI techniques include machine learning, reinforcement learning and deep learning, which have numerous applications inside and outside of the metaverse . One of the main use cases for AI inside the metaverse will be controlling non-player characters (NPCs). Such characters are used to interact with users in the form of assistants, enemies, or characters in a story . AI-powered NPCs, which will be trained through customer interactions, will be especially important for the purpose of consumer interactions, offering users unique interactions. Researchers are expecting AI-powered NPCs to play a big role in the metaverse and predict that the majority of interactions will not be human-to-human but human-to-AI . While the potential for AI is very promising, the models on which these applications run are complex and resource intensive, making them unfit for mobile devices . Running a virtual world requires a vast amount of computing resources to simulate the world's physics, collisions etc. Older virtual worlds such as Second Life have used centralised servers, often in the cloud, for such computational efforts. With increasing data and computational demand, this approach can limit the number of users in a certain space and cause latency issues . It addresses the latency issues by distributing computing resources and data storage closer to the end-user . As latency is one of the primary influences on a user’s sense of immersion, minimising it is extremely important.

Keywords: ['virtual', 'metaverse', 'world', 'use']

Polarity: Neutral (0.09)

Subjectivity: 0.46 / 1.0

## Metaverse Platforms

Platforms such as Roblox, Decentraland and The Sandbox offer users the possibility of taking part in a shared virtual world . Without a general definition of the metaverse, it is almost impossible to differentiate, which platforms are part of it . Attempts have been attempts to categorise the current metaverse platforms based on various dimensions . The proposed models place platforms into one of four categories based on two or more dimensions . In terms of the interface, the model distinguishes between 2D and 3D worlds . The combination of the two dimensions results in four distinct metaverse types .

Keywords: ['virtual', 'world', 'metaverse', 'platforms']

Polarity: Neutral (0.08)

Subjectivity: 0.35 / 1.0

## Shopping Experiences in the Metaverse

The following section will focus on the metaverse as a means to create shopping experiences to participate in the newly emerging field of virtual commerce . The section will examine what it offers, and how it compares to other channels, mainly traditional e-commerce . Researchers have been evaluating which factors influence the virtual shopping experience and how virtual spaces should be designed for the optimal experience . Some of the most notable virtual shopping experiences that are currently available will be showcased . This will serve to show some practical examples, allowing for a comparison of aspects such as offered products and the type of virtual environment the companies have chosen .

Keywords: ['virtual', 'metaverse', 'shopping', 'experiences']

Polarity: Neutral (0.14)

Subjectivity: 0.38 / 1.0

## Virtual-Commerce

As users spend an increasing amount of their time in virtual spaces, virtual platforms have seen an increase in transactions between users who sell and buy through such platforms . The emergence of v-commerce has in great part been enabled by advances in immersive technologies such as VR, AR and virtual worlds, that allows for the simulation of immersive virtual spaces . As opposed to 2D images, customers view products in an immersive manner that is closer to the experience provided by traditional brick-and-mortar stores . V-commerce as a channel, promises to solve problems related to time and space .

Keywords: ['p.', 'virtual', 'commerce', 'spaces']

Polarity: Neutral (0.09)

Subjectivity: 0.42 / 1.0

## vs. e-commerce

At its heart v-commerce is a form of digital commerce . It is defined as “the advertising, sales, and distribution of products and services through the Internet network” E-commerce has allowed businesses to increase their reach and offer customers a service that is available to them at all times . While still a digital channel, it provides customers with an experience that is unique and interactive . The difference in provided shopping value shows that these channels don’t necessarily compete for the same target audience, as consumers looking for a hedonic experience will favour an immersive shop .

Keywords: ['commerce', 'shopping', 'e', 'experience']

Polarity: Neutral (0.08)

Subjectivity: 0.38 / 1.0

## Influencing factors on the virtual shopping experience

Companies are showing increasing interest in using the metaverse as a channel to provide immersive shopping experiences . The concept of using virtual worlds for commercial purposes has been tried in various virtual spaces such as Second Life in the mid to late 2000s . The reviewed literature includes papers that examine current metaverse platforms as well as earlier virtual worlds . This section will seek to find the factors influencing virtual shopping by evaluating various research results . The review will also try to find out what factors are influencing the factors in creating an immersive shopping experience .

Keywords: ['virtual', 'shopping', 'experiences', 'interest']

Polarity: Neutral (0.08)

Subjectivity: 0.43 / 1.0

## V-commerce products and spaces

A study by Xi and Hamari reviewed 72 academic sources on virtual shopping . The review found that 37.35% of virtual retail environments were used to create single retail stores . Food and non-alcoholic beverages were displayed most commonly (30.12%) in the study . Head-mounted displays were the by far the most used interface device, with a usage rate of 65.05% . Meanwhile, virtual shopping malls were only found in 4.82% of the reviewed literature . It is questionable whether such a major preference for head-mounted display over monitors would also be found among regular consumers .

Keywords: ['virtual', 'shopping', 'head', 'aspects']

Polarity: Neutral (0.08)

Subjectivity: 0.49 / 1.0

## Influencing factors

As such, numerous research papers have studied how virtual shopping spaces affect a consumer’s purchase intention and have tried to isolate the influencing factors . The findings of this research are being used by current metaverse studies, which try to evaluate, how store atmospherics translate from physical to virtual retail spaces . Research on online atmospherics shows that its influence on purchase decisions is stronger compared to in-store shopping and is essential for creating engaging virtual communities . With the move from in-store and (2D) online commerce to v-commerce, multiple authors have attempted to create an updated or entirely new typology of influencing factors. While some of the evaluated studies focus specifically on atmospherics, others examine the virtual shopping experience as a whole. Wu et al. performed a study including 170 undergraduate participants and evaluated virtual retail stores created by the participants in a 3D modelling software. The study concluded that atmospheric elements could be classified into pathfinding assistance features, environment features or as product presentation features. Additionally, they highlight the effectiveness as well as the necessity for pathfinding features, which eased the navigation of the store and helped to maintain user engagement . Using these categories to compare virtual and physical stores, the research found that in terms of atmospherics, virtual stores borrow much more from physical stores than from 2D websites. However, compared to physical stores, store interior elements are often used for entertainment, as opposed to functionality or aesthetics. While small stores display products as two-dimensional images, which take up less space, bigger stores tend to display products as 3D models . Looking beyond atmospheric, additional research has focused on virtual store layouts and how these compare to the layouts utilised in physical stores. Commonly used retail store layouts include the grid, racetrack, and freeform layout. The layout a store implements has been shown to influence the shopping experience and as such layout choice is very much dependent on what the store sell. Grid layouts, which offer easy navigation, are often used for stores in which customers demand utilitarian value, such as grocery stores. Freeform layouts, on the other hand, are “perceived as the most pleasant, entertaining, and stimulating layout by consumers” . Consequently, freeform layouts have been identified as the ideal layout for virtual stores, as they complement the hedonic nature of virtual shopping experiences . While the above-mentioned studies focus on internal factors influencing the shopping experience, other studies have focused on or included external factors. Research on the acceptance of v-commerce has shown that next to shopping value, age is one of the main determinants for technology acceptance. Younger (18-34) technology-aware consumers are more motivated to partake in virtual shopping than older consumers, who feel less inclined to give up their shopping habits. As in physical retail, the number of external and internal factors influencing consumer behaviour is quite large. Through a systematic literature review, Shen et al have created a list of 15 external and internal factors, which ultimately influence the consumer purchase decision. More interestingly, the identified model was used to propose a reference model of design artefacts and requirements for v-commerce applications. Each requirement can be mapped to various design artefacts that influence purchase intention, examples of which can be seen in figure 5. The model offers a starting point for businesses building v-commerce applications, as well as a basis for researchers to evaluate them .

Keywords: ['virtual', 'factors', 'shopping', 'stores']

Polarity: Neutral (0.14)

Subjectivity: 0.37 / 1.0

## Current virtual shopping experiences

The metaverse is becoming an increasingly attractive channel for organisations . The viability of virtualizing one’s business has in great part been influenced by the circumstances of the Covid-19 pandemic and the restrictions that came with it . Apparel companies have been one of the first movers, in the attempt to virtualize . Luxury fashion brands such as Gucci and Vans have shown interest in the metaverse . Samsung released its 837X Experience store on the Decentraland platform in January of 2022 .

Keywords: ['virtual', 'metaverse', 'Nike', 'apparel']

Polarity: Neutral (0.16)

Subjectivity: 0.42 / 1.0

## Metaverse Development

This will include some of the basic concepts of 3D rendering as well as common design patterns used for the development of virtual spaces . The topics covered in this section will offer an overview of development practices but mainly provide the theoretical background necessary for later practical sections . The last main section of this literature review will examine the underlying technology used to build virtual worlds such as the metaverse . The next section will examine how some of this technology is used to develop virtual worlds . This will be the last section of the literature review .

Keywords: ['section', 'virtual', 'development', 'main']

Polarity: Neutral (0.0)

Subjectivity: 0.31 / 1.0

## Building Virtual Worlds

Virtual worlds use a real-time 3D graphics system, which enables users to explore and navigate through virtual space . The process of rendering involves the use of 3D data, which is transformed to be displayed on a 2-dimensional interface . Realtime Interactive Systems (RIS) are commonly used in video game engines such as Unity3D . ECS architecture fundamentally differentiates between the application's data, in the form of entities, and the systems which act on the data . In the classical object-oriented programming paradigm, data and systems acting upon it are typically encapsulated together within classes .

Keywords: ['data', '3D', 'virtual', 'systems']

Polarity: Neutral (0.02)

Subjectivity: 0.4 / 1.0

## Virtual World Platforms & User Generated Content

Metaverse platforms offer developers an environment in which they can develop and publish their virtual experience . As of today, a multitude of these platforms exist, with popular examples being Roblox, Decentraland, Second Life, The Sandbox, Spatial and Fortnite . These platforms combine social network aspects as seen in social media platforms and have a virtual economy that often makes use of blockchain technologies such as NFTs . The combination of a virtual world and tools to construct it has been called an Integrated Virtual World Platform (IVWP)

Keywords: ['UGC', 'virtual', 'platform', 'metaverse']

Polarity: Neutral (0.09)

Subjectivity: 0.43 / 1.0

# Methodology

This section will describe the development and implementation of a white-label shopping solution for the metaverse . The development process as defined will be followed, starting with the definition of the solution's requirements and ending with an overview of the design artefacts used to meet them . The solution will be explained from various viewpoints . The focus will switch to the actual implementation of the . solution and the technologies utilised to build the solution . The project will provide some context about the project and explain the business model .

Keywords: ['solution', 'section', 'development', 'overview']

Polarity: Neutral (0.0)

Subjectivity: 0.18 / 1.0

## Context & Motivation

Worldline SA is a French CAC 40 listed company, which specialises in the field of payments technology . The development and launch of the white-label metaverse solution was conducted parallel to this thesis . A 2022 report by McKinsey estimates the daily metaverse trading volume of NFT to be around USD 250 million . Worldline and companies like it, recognize a significant opportunity to establish v-commerce as a third major payments channel, in which they can offer payment acceptance solutions . The solution can be seen as Worldline's initial steps in establishing itself as a major player in the emerging metaverse space .

Keywords: ['metaverse', 'Worldline', 'payments', 'solution']

Polarity: Neutral (0.09)

Subjectivity: 0.33 / 1.0

## The Solution

The Worldline white label metaverse offering aims to provide customers with the opportunity to easily set up a metaverse presence . The solution has taken on the shape of a virtual mall, comprising individual stores, which serve as the solution’s white-label component . Users can access the virtual mall on the Decentraland metaverse platform, which it was specifically developed for . The platform offers a web application that users can access through their browsers . Parcels can be purchased by users using the MANA currency that can be used to make purchases within the platform .

Keywords: ['virtual', 'users', 'Decentraland', 'stores']

Polarity: Neutral (0.14)

Subjectivity: 0.44 / 1.0

## Business Model

Worldline’s white-label metaverse solution enables its customers to easily build up a metaverse presence where they can offer shopping experiences . Within worldlines virtual mall, customers are quickly able to set up a store, which will be customised to fit the company's look and feel . The solution uses a subscription-based revenue model, in which customers pay a recurring fee to gain access to a shop inside the virtual mall . Worldline can help customers set up targeted metaverse advertisements as well as phygital, AR and VR versions of their products .

Keywords: ['solution', 'customers', 'Worldline', 'business']

Polarity: Neutral (0.13)

Subjectivity: 0.47 / 1.0

## Solution Development

The following section will cover various aspects of the solution development . This will include the development process, requirements and design artefacts that culminated in the final launch product . To follow the process in sequential order, the section will begin by explaining how the . development process was structured and discuss the tools and technologies that were utilised as part of it . Subsequently, the requirements of the . solution will be defined followed by a review of the design . artefacts used to meet each requirement . The . solution was designed to meet the requirements and meet each of the requirements .

Keywords: ['development', 'process', 'section', 'solution']

Polarity: Neutral (0.0)

Subjectivity: 0.41 / 1.0

## Development Process

The process of implementing the solution was split into three main phases starting with the initial requirements analysis, followed by the implementation of the base solution . The implementation of individual stores as well as the continuous integration and deployment of the solution . With the base implementation completed, the solution met all of the defined functional requirements and was in a launch-ready state that could be offered to potential customers . With nine initial slots sold, the mall was launched onto the live Decentraland servers . The launch marked the end of the project as such and the transition to post-launch operations saw further integration and modifications .

Keywords: ['requirements', 'solution', 'implementation', 'launch']

Polarity: Neutral (0.01)

Subjectivity: 0.43 / 1.0

## Technology Stack

Being a superset, all valid JavaScript code is also valid TypeScript code, making the transition from JavaScript to TypeScript very easy. Furthermore, the addition of types increases the readability of the code, thereby easing future modifications. While the platform itself is built on top of the Unity game engine, Decentraland requires developers to utilise its software development kit (SDK) to develop for the platform. It requires the use of TypeScript and utilises an entity-component-system architecture with the addition of some basic object-oriented elements. VS Code is the recommended code editor for Decentraland development and offers the official Decentraland Editor extension, which can be installed from the VS Code extensions tab. It provides an extensive 3D creation suite featuring 3D creation functionality such as 3D modelling, animations, rendering etc, which are utilised for the creation of 3D models . Within the development process, Blender was used for 3D modelling, 3D animations as well as the editing of existing models. The tool was especially effective in decreasing triangle counts of 3D models, with its built-in Decimate modifier, which was often necessary to remain below the scene resource limitations. Inkscape is a vector graphics editor that is utilised to create and edit vector images as well as other image formats. Like Blender, Inkscape is an open-source software and completely free of charge. While customers received a template stating the exact specification, many of them supplied their marketing material in the wrong formats and dimensions. Inkscape was used to reformat such images to meet the exact requirements, while not compromising image quality. Moreover, the tool was used in conjunction with Blender, which can utilise vector graphics as the base for 3D models. Inkscape offers a multitude of options for tracing vector images from bitmaps. Using these capabilities, customers' marketing material could be imported to Blender, where it was used to create 3D models. The Awesome Repository is a publicly available GitHub repository that was created by the Decentraland DAO and has been maintained and extended by community contributors . The repository links to over 50 Decentraland scenes, which act as examples of how common features can be implemented. As the Decentraland documentation is rather limited, these example scenes were an extremely helpful resource during the implementation. In addition, all assets used in the repository, such as 3D models and textures, are publicly available.

Keywords: ['3D', 'Decentraland', 'TypeScript', 'development']

Polarity: Neutral (0.16)

Subjectivity: 0.48 / 1.0

## Solution Requirements

Requirements were grouped using the five design requirement categories for virtual commerce platforms proposed by Shen et al. Each requirement was mapped to at least one artefact, which was implemented in form of a work package . Implementation of design artefacts will be covered in section 3.2.3. While requirements will be explained in this section, the implementation of the artefacts is covered in the other section of this section . The following requirements were defined prior to the development of the solution and were defined to help with the creation of the .

Keywords: ['design', 'requirements', 'artefacts', 'requirement']

Polarity: Neutral (-0.1)

Subjectivity: 0.17 / 1.0

## Forms of Immersive Technology: Accessible Virtual Space

As its most fundamental feature, the solution must provide users with a 3D virtual space, which they are able to fully explore . Users must be able to move freely within this space without being limited to any fixed paths . Entering the virtual space must be intuitive and should be done without encountering major entry barriers . This should result in a user-friendly experience, which encourages potential new users to try out the solution . The solution should provide a sense of immersion and an engaging experience, experts say .

Keywords: ['users', 'space', 'solution', 'virtual']

Polarity: Positive (0.25)

Subjectivity: 0.55 / 1.0

## Interface: Sense of Presence

As a sense of presence is one of the main determinants for users purchasing intention, the solutions user interface, in the form of the virtual mall and its shops, should be designed interactively and responsively . In greater detail, this means that the mall and store layout should feel intuitive and be easy to navigate by the user, minimising the time spent searching for a product . In terms of the store’s offerings, the products on display must look and feel authentic . These should allow the user some degree of interactivity and provide responsive feedback .

Keywords: ['user', 'mall', 'store', 'sense']

Polarity: Positive (0.3)

Subjectivity: 0.5 / 1.0

## Interface: Scalability

The proposed solution intends to support up to 15 virtual stores at the outset . However, the interface of the solution must be designed with the flexibility to expand and accommodate an even larger selection of tenants in the future . The scalability of the proposed solution will become particularly crucial when considering its deployment across various geographical regions . The primary focus of the initial launch will be on European customers, it is vital that the solution is adaptable and can cater to the demands of other regions, such as North America, Asia, or Oceania .

Keywords: ['solution', 'stores', 'virtual', 'interface']

Polarity: Neutral (0.1)

Subjectivity: 0.42 / 1.0

## Performance: Resource Management

Every Decentraland parcel represents a 3D rendered scene, which requires computational resources . The platform has defined a set of scene limitations which every scene is required to follow . The scene limits concern multiple 3D resources, which are utilised to build the virtual space, as well as size constraints for files uploaded to the platform’s content servers . Some of these limits grow with the number of parcels a scene contains, leading to multi-parcel land plots, such as the 4x2 plot used for the white label solution, seeing demising returns for each additional parcel .

Keywords: ['scene', 'resources', 'parcel', 'platform']

Polarity: Neutral (0.07)

Subjectivity: 0.36 / 1.0

## Performance: Scene Performance

The number of resources a scene uses and how these are implemented greatly influences the performance of the scene, in terms of the frames per second the user experiences . Having a smooth frame rate is of utmost importance for the solution, as it influences usability as well as the immersive experience . Achieving an expectable frame rates is a functional requirement, while high framer ates, that increase the level of immersion, will be seen as a qualitative requirement . It should however be noted that measuring the success of this requirement will present a challenge, as frame rates are very much dependent on the hardware, specifically the presence of a GPU .

Keywords: ['frame', 'scene', 'requirement', 'performance']

Polarity: Neutral (0.09)

Subjectivity: 0.4 / 1.0

## Intelligence: Modular Store Design

Stores should be designed in a modular manner . All customizable elements should be added to the base product as components . Components must be created for the store's branding, products, advertisement, social media and video and audio options . The use of modules should make for a more scalable solution as modifications and additions can be added without the need to rework other sections of the codebase . The stores themselves should be implemented as self-contained modules that can easily be moved around without any effect on the store’s interior .

Keywords: ['store', 'modules', 'Stores', 'modular']

Polarity: Neutral (0.07)

Subjectivity: 0.53 / 1.0

## Function: Payment Integration

Decentraland allows users to purchase and sell virtual goods and land on their platform, but these transactions can only be made using the platform's own cryptocurrency MANA . This will display a problem for most store owners wanting to sell directly through the platform as accepting a cryptocurrency will add a further layer of complexity . Therefore, the solution must offer store owners the option of accepting regular fiat currency from within their virtual store . The integration of the payment acceptance method should be as seamless and convenient as possible and conducting a transaction should not require the user to leave the platform .

Keywords: ['platform', 'store', 'virtual', 'cryptocurrency']

Polarity: Neutral (0.16)

Subjectivity: 0.57 / 1.0

## Function: User Analytics

To provide an overview of the solution's usage and user preferences, the solution must integrate a method of collecting user data . This data will help provide a thorough understanding of the solutions' usage . The collected data should offer insights into user behaviour, such as the preferred areas and stores of the mall . These insights will help monitor the solution in terms of usage and provide a better understanding of user preferences which will help inform future design decisions, which will be made in the mall's design decisions in the future .

Keywords: ['user', 'solution', 'usage', 'preferences']

Polarity: Neutral (0.14)

Subjectivity: 0.36 / 1.0

## Implementation

With the requirements defined, the subsequent section will focus on the implementation of these . Each requirement was mapped to one or more design artefacts, which were implemented during the implementation phase . These artefacts will be covered in this section, with the focus lying on their implementation and how they met their matching requirement . The following table provides an overview of all solution requirements, which have been clustered using the requirements categories proposed by Shen et al. The right column of the table shows each requirement’s design artefact .

Keywords: ['requirements', 'implementation', 'requirement', 'section']

Polarity: Neutral (0.12)

Subjectivity: 0.27 / 1.0

## Virtual Shopping Mall

The virtual shopping mall is the canvas for the entire solution and as such was the first artefact to be implemented . The mall utilised the 4x2 land plot, which was rented on the Decentraland marketplace and provided a 64x32x63 metre area . Each floor scene, except for the event space, contains a total of five stores, the maximum number the land plot could accommodate . Glass materials were used on the street phasing sides, allowing users to view the stores from the outside .

Keywords: ['building', 'mall', 'scene', 'floors']

Polarity: Neutral (0.11)

Subjectivity: 0.43 / 1.0

## Mall Atmospherics and Layout

Virtual store atmospherics plays a crucial role in creating a virtual space that offers users a sense of immersion and presence . In order to build an experience, multiple pathfinding, environmental and product presentation features were implemented to promote the scenes' atmospheric design . These features will be explained in the following section of the article . The following section will also explain how the store's atmospheric design was created . The store's product presentation and pathfinding features are included in this section . The product presentation feature is a key part of the story .

Keywords: ['features', 'Virtual', 'store', 'atmospherics']

Polarity: Neutral (0.02)

Subjectivity: 0.22 / 1.0

## Environmental features

The aim was to create a modern and visually pleasing look, with some futuristic elements befitting the metaverse . Glass materials were used whenever possible, with the addition of wooden materials on the building’s backside and floors . Neon light strips were used to outline the building's edges, giving it a distinct look . The futuristic theme was further expanded upon in the interior, through the use of hovering advertisement billboards and teleporters . Store owners can include products, branding, advertising, social media, as well as audio and video options .

Keywords: ['building', 'lighting', 'store', 'theme']

Polarity: Neutral (0.11)

Subjectivity: 0.35 / 1.0

## Product presentation features

The product presentation features include all “Methods of showing individual products and product information” These features mainly pertained to the product module, which was implemented to utilise all display options the Decentraland SDK offers . Product information is displayed by hovering over the product, in form of a short description, and by clicking the product to a specified description page . Custom components and systems were implemented to bring products to life and increase 3D authenticity . This included the addition of animation systems to add rotation as well as vertical and horizontal movements to products .

Keywords: ['product', 'products', 'features', 'information']

Polarity: Neutral (0.13)

Subjectivity: 0.32 / 1.0

## Pathfinding features

The pathfinding features included navigational elements as well as the layout of both the mall building and the individual stores . In terms of layout, stores were placed in a row of five per floor . The standard layout utilises a racetrack approach, which allows for a total of seven products, four on the outside and three in the middle, a social media section, and a video screen . The linear layout was used due to the space constraints of the scene, which would only allow for the stores to be placed in this fashion .

Keywords: ['layout', 'stores', 'floor', 'store']

Polarity: Neutral (0.08)

Subjectivity: 0.35 / 1.0

## Geo-Location

Geo-location functionality was added to allow the solution to scale into other geographic regions in the future . To incorporate this feature, the solution must determine the user’s geographical origin, which is based on their IP address, and render the mall stores that are mapped to that region or country . At the time of writing, geo-location specific stores are not yet being utilised as there is simply no demand for them at present . However, should specific regions display interest, this is an effective measure to easily scale the solution .

Keywords: ['API', 'location', 'solution', 'regions']

Polarity: Neutral (0.1)

Subjectivity: 0.38 / 1.0

## Scene Management

The main building includes up to four floors, with each floor displaying multiple 3D models and images . The scene is rather dense in terms of content, which presents a problem due to the scene resource limits set by Decentraland . After building and store contents were initially implemented, the scene exceeded the triangle, material, and texture resource limits by more than double, meaning it could not have been deployed . Lazy loading is a common design pattern used to improve application performance, by not loading content upfront but as it is needed . To alleviate this problem a lazy loading system was implemented .

Keywords: ['scene', 'sub', 'scenes', 'engine']

Polarity: Neutral (0.1)

Subjectivity: 0.6 / 1.0

## Modular Stores

With the scene containing up to 15 stores, each containing over ten entities, it was essential to use a structured approach to manage the scene's content . A modular approach was employed, building on the sub-scene implementation discussed earlier . Content modules were defined for every configurable aspect of the store, resulting in five modules at the time of launch . Each module consisted of two components: the module's content (e.g., product models, names, animations, and descriptions) and the script that implements the content .

Keywords: ['store', 'content', 'entities', 'modules']

Polarity: Neutral (-0.01)

Subjectivity: 0.41 / 1.0

## Payment Links

Worldlines online payment solution Saferpay generates payment links for virtual shops . These payment links can be accessed by clicking on a virtual product and selecting the "buy" option . Worldline will receive a transaction fee for every successful transaction . The solution also enables merchants without online shops to include payment links in their invoices, which their customers use to pay . For shop owners that want to sell directly from their virtual store, payment links are generated with the SaferPay solution . For more information, visit www.worldlines.com/Worldlines .

Keywords: ['payment', 'links', 'solution', 'virtual']

Polarity: Neutral (0.14)

Subjectivity: 0.48 / 1.0

## Crypto ATM

Decentralands officially uses the MANA cryptocurrency, which is its domestic currency . MANA can be bought on various popular crypto exchange platforms, which requires users to access another platform . Multiple crypto ATMs have been integrated into the mall building to make it easier for stores to accept currencies . The ATMs offer a user interface where users can choose whether they would like to buy or sell currency . For users, this is an easy way of buying the necessary funds, which they can spend within the mall or in any other scene .

Keywords: ['ATMs', 'MANA', 'users', 'crypto']

Polarity: Neutral (0.12)

Subjectivity: 0.55 / 1.0

## Atlas Analytics

The Decentraland platform was created from a grant given by the DAO and is one of the officially recommended analytics solutions . At present, this platform is free to all Decentralsand landowners . Atlas analytics was integrated into the solution to gain additional insights . Metrics include the number of scene users, their geographic origin, the percentage of guests versus registered users, a scene traffic heat map, as well as device, and browser statistics . In addition, developers can track specific events within the scene, such as how often displayed products were clicked .

Keywords: ['platform', 'users', 'analytics', 'scene']

Polarity: Neutral (0.06)

Subjectivity: 0.39 / 1.0

# Analysis

The white-label metaverse solution was launched on the eighth of March 2023 in Decentraland . It was launched as a three-floor building, with a total of nine stores . The following section will be used to showcase the results, including an overview of the customers the solution was able to attract and how these used the content modules to configure their store . These results will be followed by a discussion and analysis of the results . The results will also be showcased, including various user statistics .

Keywords: ['solution', 'results', 'half', 'months']

Polarity: Neutral (0.07)

Subjectivity: 0.43 / 1.0

## Customers

A total of nine stores were implemented at the time of launch, which included eight customer stores . Table 6 provides an overview of the customers renting a store within the mall . All companies, except for Naked Life, have European origins with five of the eight customers originating from either Switzerland or Germany . In terms of company size a majority of the companies fall into the small and medium-sized enterprise (SME) category, with a median size of 50 employees, excluding Worldline . The building was launched with three total stories as opposed to four, with six further stores .

Keywords: ['store', 'total', 'stores', 'customers']

Polarity: Neutral (0.03)

Subjectivity: 0.39 / 1.0

## Store configuration

The product and media modules were divided into their main options of 3D models, images, and NFTs and videos and audio respectively . Table 7 showcases which modules were utilised for each store, and to which extent . The media module was utilised by all but three customers, who used neither video nor audio elements . The advertisement module was made use of by all stores except SNGLR, which chose to utilise this store space for Nfts . None of the stores used payment links to allow users to buy their products .

Keywords: ['stores', 'module', 'customers', 'store']

Polarity: Neutral (0.13)

Subjectivity: 0.43 / 1.0

## User metrics

Data on the scene’s usage was collected using atlas analytics and was collected starting with the solution's launch . Table 8 provides an overview of the most relevant metrics that were collected . Within the first three weeks following the launch of the solution, the scene was visited by a total of 145 users, leading to a weekly average of 48 users . Users visiting the space spend an average of nineteen minutes within the mall . 95 % of users accessed the scene through Decentraland’’�s web application, while only 5% utilised the client .

Keywords: ['users', 'launch', 'scene', 'weeks']

Polarity: Neutral (0.11)

Subjectivity: 0.39 / 1.0

## Discussion

Worldline's white-label metaverse solution is the company's first commercial venture into the metaverse . The launch of the solution provided valuable data and insights into the type of customer segment interested in this solution . The findings suggest that the solution can help non-IT companies, which lack the time and know-how to develop a solution of their own . SMEs could be a main target segment, which comes back to the aspect of limited resources . While brands see value in the solution, it is unclear whether consumers see any appeal in this kind of virtual experience .

Keywords: ['solution', 'development', 'Decentraland', 'metaverse']

Polarity: Neutral (0.13)

Subjectivity: 0.41 / 1.0

# Conclusion

A virtual shopping mall solution was developed for the metaverse platform Decentraland . This solution aimed to offer customers a virtual white-label store, which they are able to configure using their branding and the products and advertising elements they want to display . The solution was followed by the successful launch of the solution with a total of eight customers renting a store within the mall . Initial success suggests that especially small to medium-sized companies are interested in such a solution, which allows them to quickly set up a shop in a metaverse to explore this new channel .

Keywords: ['virtual', 'solution', 'metaverse', 'Decentraland']

Polarity: Neutral (0.13)

Subjectivity: 0.44 / 1.0

# Critical Appraisal

The project thesis was written during a three-month period while working within the Metaverse and Crypto Competence Centre at the company Worldline . Due to the limited time and scope, this thesis is only based on the implementation of the Worldline white-label metaverse solution and its launch . Going forward, further user statistics will be collected to get a better understanding of how many monthly users the solution can attract . The project experienced a setback with the loss of one of its developers during the first month of development .

Keywords: ['thesis', 'Metaverse', 'solution', 'project']

Polarity: Neutral (0.13)

Subjectivity: 0.45 / 1.0