3.2: Report on challenges and governance

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Abstract	The OPENVERSE project is a European initiative aimed at helping establish Europe as a global leader in the development and governance of Virtual Worlds technologies. With a wide range of applications, the project addresses key challenges such as technology awareness, trend analysis, cross-sectoral collaboration, interoperability, ethics, intellectual property, and societal impact. This report outlines specific IPR, and Ethics as elated challenges and governance issues and opportunities for Virtual Worlds
Keywords	Challenges, Ethics, Governance, Virtual Worlds. GDPR, Intellectual Property Right.

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PU	*Public, fully open, e.g. web (Deliverables flagged as public will be automatically published in CORDIS project's page)*	
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Classified R-UE/ EU-R	*EU RESTRICTED under the Commission Decision No2015/ 444*	
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* R: Document, report (excluding the periodic and final reports)

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patent filings, press & media actions, videos, etc.

DATA: Data sets, microdata, etc.

DMP: Data management plan

ETHICS: Deliverables related to ethics issues.

SECURITY: Deliverables related to security issues

OTHER: Software, technical diagram, algorithms, models, etc.

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EXECUTIVE SUMMARY

Deliverable 3.2, *"Report on Challenges and Governance",* forms a pivotal component of Work Package 3 (WP3), *Barriers and Policy Gaps for Governance and Business Models through Experiments*. It builds upon the foresight analysis and benchmarking presented in D3.1 to identify, categorise, and interpret the ethical, legal, socio-economic, and governance challenges shaping the development of open and human-centric Virtual Worlds in Europe.
The report consolidates evidence from regulatory frameworks (GDPR, Digital Services Act, Data Governance Act, AI Act), academic discourse, and early insights from ongoing OPENVERSE experiments to provide a multidimensional understanding of trust, privacy, intellectual property, inclusivity, and safety. It positions these as *governance obligations* rather than optional design features.

Three complementary objectives guide D3.2:

1. **Map challenges and barriers** related to ethics, law, and governance that constrain the emergence of interoperable, trustworthy Virtual Worlds.
2. **Identify gaps in current European and international standards** with respect to accountability, safety, accessibility, and digital rights.
3. **Lay the analytical foundation for Tasks 3.4 and 3.5**, where the project will codify ethical/legal requirements and design governance and IPR models.

The findings indicate that effective governance of Virtual Worlds must integrate five cross-cutting dimensions:

- **Transparency:** Explainable system behaviour and visible rule-setting.
- **Accountability:** Clear liability allocation across human, organisational, and algorithmic actors.
- **Privacy and Data Sovereignty:** User control, data minimisation, and verifiable credentials.
- **Well-being and Accessibility:** Inclusion, ergonomic safety, and cognitive comfort.
- **Economic Fairness:** Protection of creative and procedural intellectual property for individuals and SMEs.

D3.2 establishes a conceptual and regulatory baseline that will be empirically expanded through D3.3 and D3.4. These subsequent studies, led by VUB and the Lisbon Council respectively, provide concrete evidence on industrial human–robot collaboration and governance signalling in social VR environments. Their outcomes will feed directly into **Task 3.4 (Ethical and Legal Requirements)** and **Task 3.5 (IPR and Governance Models)**, led by INS, ensuring that future recommendations are both theoretically grounded and empirically validated.

By integrating ethical foresight with emerging experimental data, D3.2 positions OPENVERSE to contribute actionable, evidence-based guidance to European policymakers and standardisation bodies. The deliverable thus acts as the bridge between normative frameworks and applied governance, enabling the subsequent work packages to transform conceptual understanding into operational policy, design standards, and technological practices that embody the EU's vision for *open, secure, and human-centric Virtual Worlds*.

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ETHICS AND AI ACT ASSESSMENT — D3.2: REPORT ON CHALLENGES AND GOVERNANCE

1. ADHERENCE TO ETHICAL REQUIREMENTS OF THE EU AND AI ACT

D3.2 aligns closely with the EU Charter of Fundamental Rights, GDPR, AI Act, and the Ethics Guide for Advisors. It explicitly addresses privacy, inclusivity, transparency, and accountability as integral governance obligations for Virtual Worlds. The deliverable builds on the regulatory frameworks of the GDPR, Data Governance Act, Digital Services Act, and AI Act to define a normative foundation for trustworthy immersive environments.

The report introduces five cross-cutting ethical dimensions, transparency, accountability, privacy & data sovereignty, well-being & accessibility, and economic fairness and translates them into actionable governance mechanisms. Through the proposed Graph-RAG (Retrieval-Augmented Governance) model, ethical rules become machine-interpretable and auditable, anticipating the AI Act's Articles 11–14 on documentation, transparency, and human oversight.

D3.2 therefore demonstrates conceptual alignment with the EU's "ethics-by-design" paradigm, situating ethical and AI-risk considerations within the life cycle of governance systems rather than as ex-post compliance.

Compliance Level: High conceptual adherence.

2. MITIGATION ACTIONS REQUIRED

- Formal Ethics-Advisor Oversight, Future iterations should document formal sign-off by the Ethics Advisor or Ethics Advisory Board before publication.
- Explicit Informed-Consent & DPIA Integration, Annex future foresight and workshop activities with consent templates, pseudonymisation plans, and a brief DPIA summary (Articles 35–36 GDPR).
- AI Risk Classification & Lifecycle Monitoring, Identify any AI-supported foresight tools as limited-risk systems under the AI Act, maintaining transparency and human-in-the-loop supervision.
- Bias and Inclusivity Audits: Periodically review datasets and governance indicators for representational bias, accessibility gaps, and algorithmic inequities.
- Ethics Checklist for Governance Models: Develop a short compliance checklist linking each ethical pillar (privacy, transparency, accountability, inclusivity, well-being) to its corresponding control or evidence source within the Graph-RAG.
- Publication of Ethics Annex: Add a public annex summarising core values, data-protection obligations, and ethical risk mitigations to ensure transparency for stakeholders and policymakers.

3. OVERALL ETHICAL AND AI ACT ACCEPTABILITY EVALUATION

Overall Evaluation: High (Green)

D3.2 provides a strong ethical and regulatory framework for virtual-world governance, translating foresight analysis into measurable, future-proof ethical standards. It meets Horizon Europe's expectations for responsible innovation and anticipates the transparency, documentation, and oversight requirements of the EU AI Act. Pending the integration of formal oversight and explicit DPIA references in later deliverables, the document's ethical acceptability is rated high, with only minor procedural enhancements needed to reach full operational compliance.

SUMMARY TABLE

Deliverable	Adherence to EU Ethical & AI Act Requirements	Overall Ethical Evaluation
D3.2 – Report on Challenges and Governance	High – Fully aligned with GDPR, DSA, DGA, and AI Act;	High – Ethical and AI risk framework conceptually

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	embeds transparency, privacy, and accountability via the Graph-RAG model	robust; minor mitigation actions required for full operational compliance

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POLICY BRIEF DATA PROTECTION IMPACT ASSESSMENT (DPIA) - D3.2 REPORT ON CHALLENGES AND GOVERNANCE

1. CONTEXT AND PURPOSE OF PROCESSING

Deliverable D3.2 – Report on Challenges and Governance addresses ethical, legal, and technical frameworks for governance within open and interoperable virtual worlds. The processing of personal data in this context is minimal and primarily involves stakeholder consultation activities, such as workshops and expert interviews conducted for foresight and policy analysis. Collected data includes contact details and professional opinions shared voluntarily by participants. No special-category data are processed.

D3.2 also employs AI-supported foresight tools (e.g., Graph-RAG) for data structuring and governance modelling, under full human oversight and in compliance with the EU AI Act provisions on limited-risk AI systems.

2. LEGAL BASIS AND LAWFULNESS OF PROCESSING

Processing is carried out under the following legal grounds:

- Article 6(1)(a) GDPR – consent of the data subject for participation in consultation activities.
- Article 6(1)(e) GDPR – processing necessary for the performance of a task carried out in the public interest (Horizon Europe research objective).
- Compliance with AI Act Articles 11–14, ensuring transparency, traceability, and human oversight of AI-assisted foresight tools.

Participants receive plain-language information sheets and consent forms detailing the purpose of participation, data processing methods, and their rights.

3. DATA CATEGORIES AND PROCESSING ACTIVITIES

Type of Data	Description	Purpose	Storage & Access
Identification Data	Names, professional emails, affiliations (optional)	Contact and acknowledgment of contributors	Secure EU-based servers with access limited to authorised research staff
Research Input Data	Notes, anonymised transcripts from interviews/workshops	Governance modelling and foresight analysis	Pseudonymised and stored in encrypted project repositories
AI-generated Metadata	Machine-processed summaries and knowledge graphs	Enhance interpretability and transparency of foresight results	Retained within version-controlled, documented environments
Consent Records	Signed digital or written consent forms	Legal proof of compliance with GDPR	Stored separately from content data and deleted after project closure

4. RISK IDENTIFICATION AND EVALUATION

Potential Risk	Impact on Data Subjects	Likelihood	Mitigation Measures
Unauthorised access to contact information	Breach of confidentiality	Low	Encryption, role-based access, EU-hosted secure storage
Insufficient consent awareness	Violation of autonomy	Low	Plain-language consent forms and

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			withdrawal mechanism
AI inference errors or bias in governance models	Misrepresentation of participant input	Low	Human review of AI-assisted results; bias detection logs
Retention of data beyond project needs	Violation of storage limitation principle	Very Low	Automatic deletion or anonymisation at project end (M36)

5. DATA RETENTION AND DELETION

All personal and research-related data are retained only for the duration of the project and are deleted or anonymised after its completion (Month 36). Aggregated or pseudonymised metadata may be archived for up to five years for scientific transparency and auditing purposes.

6. DATA SUBJECTS' RIGHTS

Participants can exercise the following rights at any time:

- Access, rectification, and erasure of data.
- Restriction or objection to processing.
- Withdrawal of consent without any prejudice.
- Complaint to their national Data Protection Authority.

Requests should be directed to: info@openverse-project.eu

7. DATA TRANSFERS AND PROCESSORS

All data are processed within the European Economic Area or adequacy-approved jurisdictions. Processors are bound by GDPR-compliant Article 28 Data Processing Agreements (DPAs) ensuring confidentiality, security, and lawful use of data.

8. AI ACT AND ETHICAL OVERSIGHT

AI-supported foresight methods used in D3.2 are classified as limited-risk systems under the EU AI Act (2024/1689). The project ensures full human-in-the-loop oversight, traceability and explainability of model outputs, bias detection procedures, and documentation in the Ethics and AI Governance Annex of D3.2. Ethics oversight is provided by the independent Ethics Advisor (UNEXT Ltd.) and the OPENVERSE Ethics Committee, meeting quarterly to review compliance.

9. OVERALL ASSESSMENT

Residual Risk Level: Low

Compliance Status: Fully GDPR-compliant and aligned with the EU AI Act's transparency and human oversight provisions.

Public Disclosure: This summary meets Horizon Europe and GDPR transparency requirements for public DPIA communication.

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ABBREVIATIONS

AI	Artificial Intelligence
AR	Augmented Reality
DSA	Digital Services Act
GDPR	General Data Protection Regulation
Graph-RAG	Graph-based Retrieval-Augmented Generation
HCVW	Human-Centric Virtual World
IPR	Intellectual Property Rights
OPENVERSE	Open and Human-Centric Virtual Worlds Project

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1 INTRODUCTION AND BACKGROUND

The accelerating convergence of Virtual Worlds, immersive technologies, and artificial intelligence marks a profound transformation in how individuals, organisations, and societies interact within digital ecosystems. These environments are no longer limited to entertainment or simulation; they increasingly underpin education, healthcare, industrial operations, and public governance. Yet, as they become more integrated with physical and economic systems, questions of *trust, accountability, privacy, inclusivity, and human well-being* grow correspondingly urgent.
Within this evolving landscape, the European Union has articulated a vision for open and human-centric Virtual Worlds digital spaces that are interoperable, transparent, secure, and governed according to European democratic values. Achieving this vision demands more than technical standardisation; it requires *ethical and legal governance frameworks* capable of protecting user rights, safeguarding intellectual property, and ensuring equitable participation across industrial and societal domains.

1.1 PURPOSE AND SCOPE OF DELIVERABLE 3.2

Deliverable 3.2, *"Report on Challenges and Governance,"* represents a core analytical milestone within **Work Package 3 (WP3): Barriers and Policy Gaps for Governance and Business Models through Experiments.**
Its purpose is threefold:

1. **To identify key ethical, legal, and governance challenges** affecting the realisation of an open, trustworthy Virtual World.
2. **To map the European and global regulatory context**, highlighting misalignments, grey areas, and implementation gaps in existing frameworks such as the GDPR, Data Governance Act, AI Act, and Digital Services Act.
3. **To establish a conceptual foundation** for subsequent WP3 activities, particularly **Task 3.4 (Ethical and Legal Requirements)** and **Task 3.5 (IPR and Governance Models),** by translating conceptual insights into structured requirements and actionable policy recommendations.

1.2 POSITION WITHIN WP3

WP3 investigates the governance and policy dimensions of Virtual Worlds by combining analytical, experimental, and demonstrative approaches. It bridges early-stage trend analysis with later-stage model development and policy testing. The five tasks that compose WP3 are summarised below in Table 1:

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Table 1: WP3 Summary

Task ID	Title	Lead Partner	Timeline (Months)	Primary Output	Feeds Into
T3.1	Analysis of Trends and Benchmarking with Current Internet	IDC	M1–M12	D3.1 – Trends and Benchmarking Report	D3.2, D3.4
T3.2	Exploratory Study on Governance Challenges	INS	M13–M24	D3.2 – Report on Challenges and Governance	T3.4, T3.5
T3.3	Demonstration Case on Virtual Worlds-Enabled Robotics	VUB	M13–M24	D3.3 – Demonstration Report	T3.4, T3.5
T3.4	Ethical and Legal Requirements for European Open Virtual Worlds	INS	M18–M30	Ethical/Legal Requirement Framework	D3.5, WP6
T3.5	IPR and Governance Models for Open and Human-Centric Virtual Worlds	INS	M18–M30	Governance & IPR Models	WP6 Roadmap

D3.2 sits at the conceptual midpoint of this sequence: it consolidates the regulatory and ethical understanding required to interpret empirical results from Tasks 3.3 and 3.4, and it guides the normative framework that Tasks 3.4 and 3.5 will formalise into governance and IPR models. It therefore performs both diagnostic and foundational functions, identifying systemic challenges while establishing guiding principles for subsequent experimental and policy work.

1.3 METHODOLOGICAL APPROACH

The deliverable adopts the following approach:

1. **Desk research and policy mapping**: Covering European, national, and international frameworks governing data protection, liability, content moderation, intellectual property, accessibility, and inclusivity in Virtual Worlds.
2. **Thematic synthesis of scholarly and institutional literature**: Focusing on ethical design principles such as privacy-by-design, fairness, accountability, explainability, and human dignity.
3. **Comparative analysis:** Between existing regulatory instruments and emerging technology practices (e.g., XR interfaces, spatial computing, and AI-driven environments);
4. **Cross-reference to OPENVERSE foresight outputs (WP2) and trend analyses (D3.1):** Align governance challenges with observed industry trajectories and user adoption patterns.

Thus, ensuring that the identified challenges are both conceptually rigorous and contextually relevant to ongoing European policy debates.

1.4 CONTEXTUAL BACKGROUND AND LITERATURE LANDSCAPE

The **OPENVERSE project** aims to strategically position Europe as a global leader in the development, deployment, and governance of Virtual Worlds. These environments represent a rapidly evolving frontier with transformative potential across diverse domains such as education, healthcare,

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manufacturing, and public services. Recognising this potential, OPENVERSE adopts an integrated, cross-disciplinary approach to address technological frameworks, interoperability standards, intellectual property rights, ethical governance, and societal implications. This effort is anchored in the European vision of open and human-centric Virtual Worlds, ensuring that technological innovation aligns with democratic values, user rights, and social inclusion.

Virtual Worlds, often exemplified by the *metaverse,* are immersive, real-time, 3D digital spaces that allow users to engage in activities parallel to the physical world through avatars, Extended Reality (XR) devices, and intelligent systems (Fernandez & Hui, 2022; Hasan, 2023). Despite remarkable progress in hardware, connectivity (5G, edge computing), and AI integration, the full potential of immersive technologies remains unrealised due to conceptual ambiguity, fragmented infrastructures, and a lack of interoperability standards (Zallio et al., 2023). These limitations highlight the urgent need for comprehensive architectures and governance frameworks that can support scalability, data integrity, and ethical compliance across heterogeneous virtual ecosystems.

From a governance perspective, the metaverse is broadly described as a "3D shared virtual environment in which human activities are mediated by augmented and virtual reality technologies," representing a paradigmatic shift towards a *persistent, interactive, and embodied Internet* (Ogunsan & Iseoluwa, 2025). This convergence of Extended Reality, AI, and blockchain raises complex challenges related to privacy, user autonomy, content moderation, and digital identity. As real and virtual interactions increasingly intertwine, traditional legal frameworks struggle to adapt, particularly concerning jurisdiction, liability, and enforcement in borderless, decentralised environments (Mitchell & Khazanchi, 2012).

Ethical concerns are equally pressing. Continuous sensing and biometric tracking in immersive devices exacerbate risks of surveillance and data exploitation, while hyper-realistic interactions can amplify psychological harm and harassment (Maloney et al., 2021). Emerging phenomena such as "deepfakes," identity theft, and *darkverses* closed, illicit virtual spaces further challenge existing cybersecurity and law enforcement paradigms (Tariq et al., 2023). Scholars and policymakers agree that safeguarding users in these contexts demands a proactive combination of technological safeguards, legal instruments, and ethical design principles.

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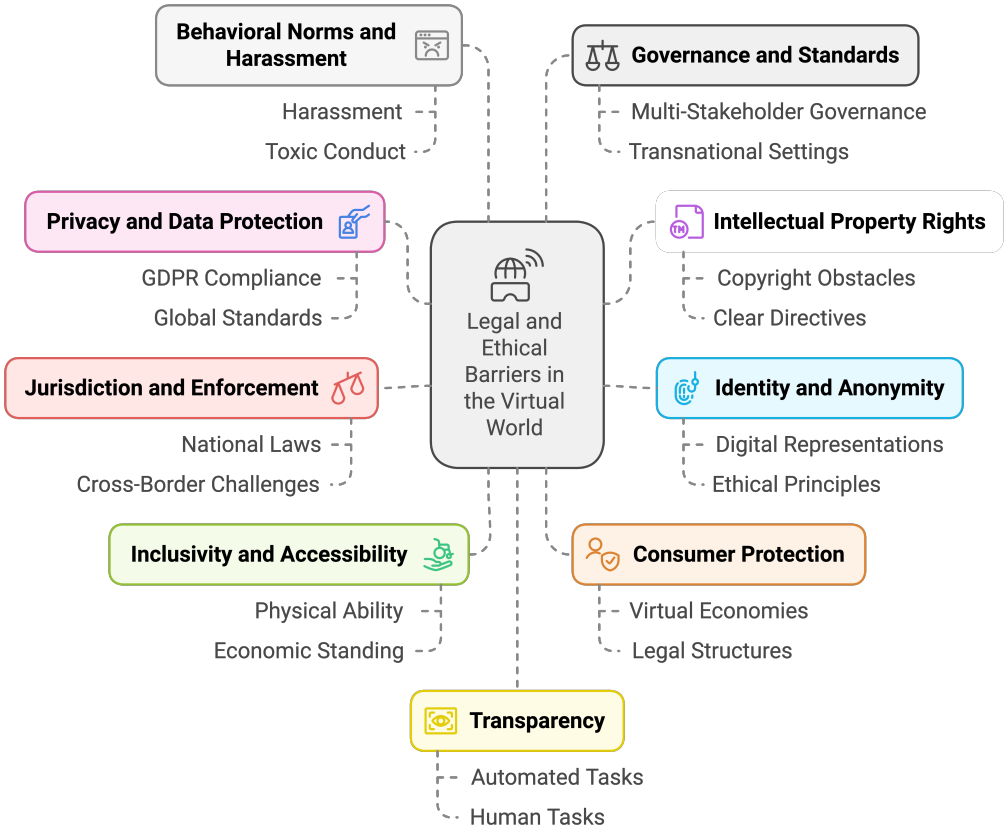

Figure 1: Legal and Ethical Barriers in the Virtual World

Within Europe, legislative and policy instruments such as the **General Data Protection Regulation (GDPR)**, **Digital Services Act (DSA)**, and **Data Governance Act (DGA)** provide foundational governance tools for privacy, data accountability, and content regulation. Complementary national initiatives, including the Netherlands' *Ethical Guidelines for the Metaverse* and Germany's *AI Ethics Code for Virtual Worlds,* illustrate a growing recognition of the need for harmonised ethical governance across Member States. Collectively, these frameworks embody Europe's commitment to trustworthy, transparent, and rights-based digital ecosystems, even as they must evolve to address the distinctive risks posed by immersive environments.

This evolution can be viewed as a gradual but deliberate shift from reactive regulation to proactive ethical design. The process moves from initial recognition of exploitation and privacy concerns in unregulated environments toward the institutionalisation of user rights, transparency, and accountability as design imperatives. Figure 1 visualises this progression, showing how successive policy and ethical milestones from EU-level legislation through national guidelines to proactive design choices collectively advance the European vision of a *Trustworthy Digital Future.*

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Figure 2: Pathway to Ethical and Legal Virtual Worlds: From Risks to a Trustworthy Digital Future

This diagram illustrates a progressive strategy for transforming virtual environments from unregulated and potentially exploitative spaces into ethical, legally compliant, and trustworthy digital ecosystems. Beginning with *Unregulated Virtual Worlds*, where data exploitation and privacy breaches dominate, the pathway advances through regulatory frameworks such as the *EU Digital Services Act* (ensuring data protection and moderation), the emergence of *National Ethical Guidelines* (promoting user rights and transparency), and the adoption of *Proactive Design Choices* (embedding ethics into technical architectures). The culmination is a *Trustworthy Digital Future* that safeguards individual rights while enabling responsible innovation.

At the same time, the scholarly literature reveals persistent gaps in empirical validation and implementation guidance. While frameworks for ethical design and data protection abound, their operationalisation in XR and virtual-world contexts remains underexplored (Scoping Review, Open Research Europe, 2023). Researchers emphasise that ethical principles such as fairness, transparency, and autonomy must be translated into enforceable governance mechanisms through *law, design, and institutional oversight* (Hasan, 2023). Table 1 summarises key contributions across the 2012–2025 literature, highlighting trends, innovations, and remaining challenges in virtual-world governance.

Table 2: Comparison of trends, innovations, and existing challenges in VW governance from 2012-2025.

Year	Scope & Focus	Contributions	Limitations	Impact & Significance
Fernandez & Hui, *Life, the Metaverse and Everything…* (2022) (arXiv)	Comprehensive review of privacy, governance, ethics pillars; modular design framework for metaverse	Thorough overview; proposed modular architecture (privacy, decision, reputation)	Framework is preliminary; lacks empirical validation	Widely cited baseline; shapes future ethical architecture design
Zallio, Ohashi & Clarkson, *Designing*	Scoping review mapping ethical	Systematic literature survey;	Limited to literature scope; lacks empirical framework	Increases awareness; guides future

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the Metaverse… **(2023) (arXiv)**	guidelines, cultural, societal research	identified research gaps; agenda-setting		research priorities
Hasan, *Governance and the Metaverse…* (SSRN 2023) (papers.ssrn.com)	Governance structures, frameworks, collaborative mechanisms	Clear taxonomy of governance models; theoretical rigor	Absence of real-world case studies	Foundation for legal/regulatory discourse; used in policy formation
Maloney et al., *Social Virtual Reality…* (2021) (arXiv)	Ethical considerations in social VR (privacy, self-presentation, harassment)	Rich domain-specific insights; highlights unique VR challenges	Focus mainly on research ethics; limited on governance/regulation	Informs research protocols and platform policy designs
Tariq et al., *Deepfake in the Metaverse…* (2023) (arXiv)	Security/privacy risks from deepfakes in metaverse workspaces/gaming	First to assess deepfake threats specific to virtual environments; uses CIA triad	Lacks suggested technical or legal mitigations	Alerts stakeholders to content authenticity issues; catalyses further solutions
Ogunsan & Iseoluwa, *Regulating the Metaverse…* (2025) (SSRN)	Jurisdiction, IP, data privacy, governance, digital inequality issues	Covers wide set of pressing legal concerns; timely and current	Conceptual; lacks implementation guidance or stakeholder views	Topical guide; starting point for adaptive legal frameworks
Mitchell & Khazanchi, *Ethical Considerations for Virtual Worlds* (2012) AIS, Elibrary)	Early recognition of social/ethical dilemmas in platforms like Second Life	Early framing; introduces case examples in virtual life events	Now dated; lacks modern virtual reality/metaverse nuance	Pioneer piece; used in subsequent VR ethics research
Scoping review on ethics frameworks (2023) (open-research-europe.ec.europa.eu)	Systematic review of ethics principles (privacy, consent, transparency)	Quantifies common principles across disciplines	Lacks domain-specific recommendations or technology focus	Helps standardize core ethics language in virtual spaces

Taken together, this body of work underscores a dual imperative: to ensure **ethical and legal safeguards** that protect individuals and institutions, and to **enable innovation and economic opportunity** in a global metaverse economy. Achieving this equilibrium requires a coordinated European strategy that integrates ethics-by-design, interoperable standards, and transparent governance models, objectives that form the conceptual foundation of OPENVERSE and are further operationalised through the analyses presented in this deliverable.

Building on the contextual and scholarly landscape outlined above, the following subsection describes the internal structure of this report and how it responds to the identified gaps and policy needs

1.5 STRUCTURE OF THE REPORT

Following this introduction, **Section 2** defines the concept of *human-centric Virtual Worlds* and outlines their socio-technical characteristics. **Section 3** examines key domains of ethical and legal

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concern, including privacy, data protection, safety, accessibility, and inclusivity. **Section 4** analyses governance gaps and regulatory challenges across existing frameworks. **Section 5** integrates empirical insights from parallel WP3 deliverables **D3.3 (Virtual-Worlds-Enabled Robotics)** and **D3.4 (Exploratory Study on Virtual World Environments)** to validate the conceptual findings of D3.2. The final **Section 6** provides an outlook on how these results inform **Tasks 3.4 and 3.5** and contribute to the **WP6 roadmap** for policy uptake and standardisation.

1.6 ROLE WITHIN THE OPENVERSE FRAMEWORK

Within the broader OPENVERSE architecture, D3.2 serves as the ethical and governance backbone connecting technical development (WP4–WP5) and policy formulation (WP6). It ensures that experimental outcomes are aligned with the EU's principles of human-centricity, openness, interoperability, and trustworthiness. By integrating conceptual analysis with forthcoming empirical results, D3.2 underpins the design of *explainable, fair, and transparent Virtual World ecosystems* that respect individual rights while fostering innovation and competitiveness.

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2 WHAT IS A HUMAN-CENTRIC VIRTUAL WORLD?

The concept of the human-centric virtual world (HCVW) encapsulates the European aspiration to build digital environments that extend human potential without compromising autonomy, safety, or dignity. Rather than treating users as passive data sources, HCVWs place the *human being,* their rights, creativity, and agency at the core of technological design and governance. This section operationalises that vision and distinguishes it from the more extractive, platform-centred models that dominate much of today's metaverse landscape.

2.1 DEFINITION AND CONCEPTUAL FOUNDATION

In the **OPENVERSE** framework, a human-centric virtual world is defined as:

''An open, interoperable, and persistent three-dimensional digital ecosystem in which people and organisations can interact, create, and exchange value under transparent, accountable, and rights-respecting conditions.''

This definition translates the EU's commitment to *a people-empowering digital transformation* into actionable design and policy parameters. Human-centricity is not a slogan but an architectural principle that shapes data governance, interface design, economic participation, and social norms inside the virtual domain.

Five interrelated pillars sustain this paradigm:

1. **Autonomy and Agency by Design**: Users maintain continuous control over identity, consent, and data flows, supported by reversible and informed-choice mechanisms.
2. **Transparency and Explainability**: Governance rules, moderation processes, and algorithmic logic are communicated in language comprehensible to non-experts.
3. **Accountability and Liability**: Every action, human or algorithmic, is traceable to a responsible entity capable of redress.
4. **Inclusion and Accessibility**: Interfaces, content, and participation models accommodate linguistic, cultural, and physical diversity, ensuring equitable access.
5. **Well-being and Sustainability**: Immersive experiences promote psychological comfort, ergonomic safety, and environmental awareness throughout the lifecycle of virtual-world infrastructure.

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2.2 CORE COMPONENTS OF HUMAN-CENTRIC VIRTUAL WORLDS

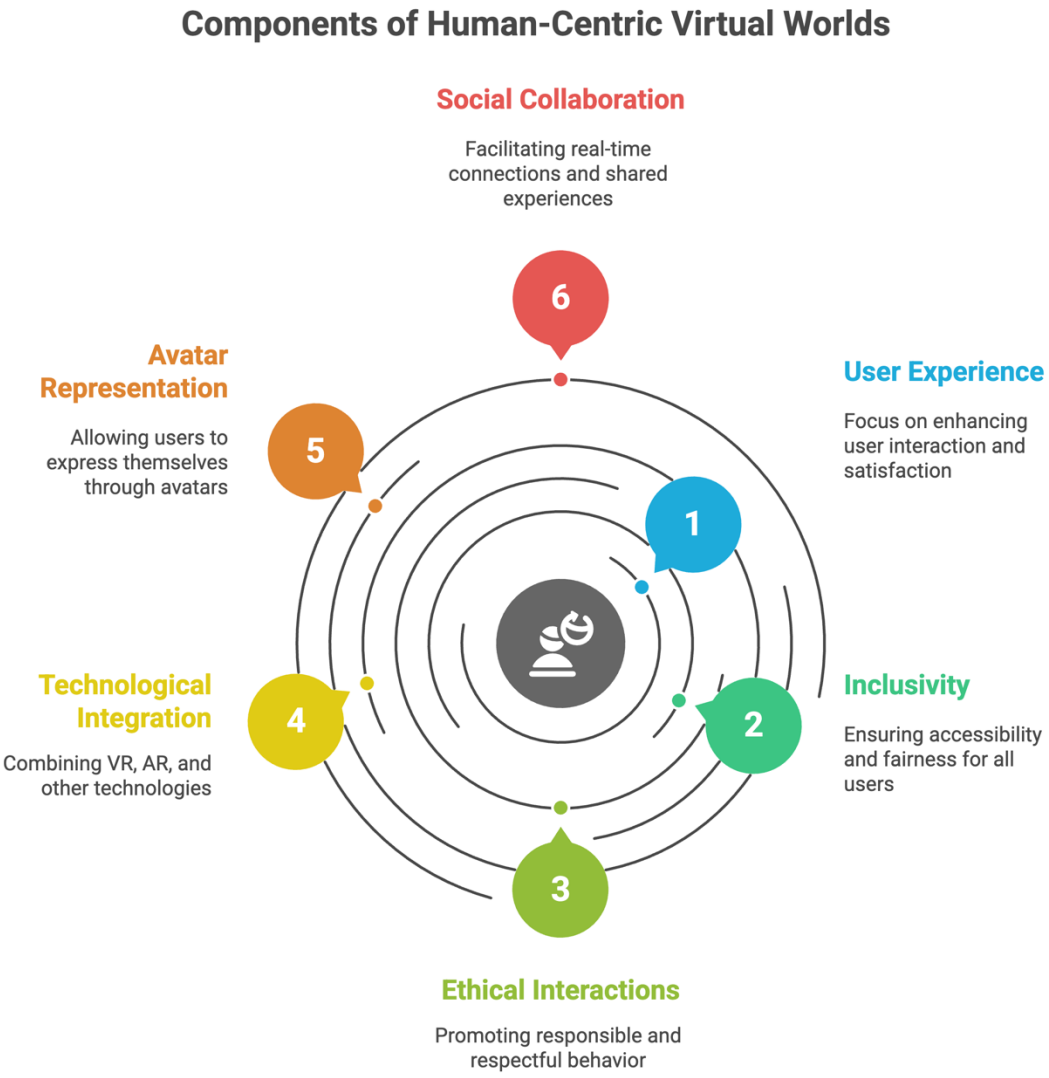

Figure 3: Components of Human-Centric Virtual Worlds.

This diagram shows six foundational components characterising human-centric Virtual Worlds: *User Experience, Inclusivity, Ethical Interactions, Technological Integration, Avatar Representation,* and *Social Collaboration*. Each dimension represents a distinct design and governance commitment essential for ensuring safe, inclusive, and trustworthy digital participation.

1. **User Experience**: Interfaces and interaction models are designed to optimise usability, cognitive comfort, and accessibility, contributing to ethical design standards explored in WP4's interface testing.
2. **Inclusivity**: Virtual spaces must accommodate linguistic, cultural, and physical diversity, enabling equitable participation.
3. **Ethical Interactions**: Codes of conduct and moderation mechanisms foster respectful behaviour and mitigate harassment or misinformation, supporting WP3's ethical-governance framework and WP2's roadmap for responsible virtual environments.

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4. **Technological Integration**: The seamless combination of VR, AR, AI, and semantic web technologies enables persistent, interoperable worlds; this aligns with WP5's technical framework and WP2's foresight on interoperability standards.
5. **Avatar Representation**: Avatars act as digital extensions of self; ethical design must protect identity integrity, privacy, and authenticity, echoing findings from D3.4 on pseudonymity and trust.
6. **Social Collaboration**: Virtual Worlds thrive on real-time, collective experiences; this dimension underpins D3.3's robotics and XR collaboration case, demonstrating the link between social presence, explainability, and productivity.

2.3 DISTINCTION WITH PLATFORM-CENTRIC MODELS

Most existing metaverse platforms operate within platform-centric architectures that consolidate data ownership and governance power in private entities. Users typically surrender informational self-determination in exchange for access, while platform operators monetise behavioural analytics and impose unilateral terms of service. Such asymmetry erodes trust and limits innovation by discouraging interoperability.

By contrast, the human-centric model advanced in OPENVERSE embraces distributed governance and data sovereignty. It advocates for open protocols, privacy-preserving computation, and verifiable credentials that allow participation across federated environments without ceding control to monopolistic intermediaries. Compliance with European regulations GDPR, AI Act, and DSA is therefore embedded not as an afterthought but as a structural design requirement.

2.4 SOCIO-TECHNICAL DIMENSIONS

Transitioning to human-centric architectures transforms Virtual Worlds along four dimensions:

- **Technical Layer:** Interoperability standards, semantic ontologies, and transparent APIs enable movement of assets, avatars, and credentials across ecosystems.
- **Economic Layer:** Fair-compensation mechanisms and traceable IPR registries protect creative and procedural contributions, especially for SMEs and independent creators.
- **Governance Layer:** Multi-stakeholder oversight replaces unilateral platform control, embedding democratic accountability through auditable governance labels and grievance channels.
- **Cultural Layer:** Design choices reflect European pluralism, supporting diverse forms of expression and social inclusion within immersive environments.

2.5 STRATEGIC ROLE WITHIN WP3

Clarifying what constitutes a human-centric virtual world establishes the conceptual foundation for the subsequent analytical and empirical work in **Work Package 3**:

- **Task 3.4 (Ethical and Legal Requirements)** will operationalise the five pillars above into measurable standards for autonomy, transparency, and inclusion.
- **Task 3.5 (IPR and Governance Models)** will translate these standards into enforceable policy instruments and governance prototypes aligned with EU normative frameworks.

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- The definition also informs **WP2**, ensuring that the final European roadmap for Virtual Worlds is built upon evidence-based, rights-preserving principles.

In this sense, human-centricity functions as both a normative compass and a design constraint, guiding how technology, policy, and ethics converge within OPENVERSE to realise trustworthy and sustainable digital ecosystems.

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3 PRIVACY, DATA PROTECTION, AND ETHICAL CONSIDERATIONS

The ethical and legal challenges of Virtual Worlds are inseparable from the technological and societal transformations they enable. As these environments evolve into fully immersive, data-intensive ecosystems, they expose novel vulnerabilities relating to privacy, data ownership, algorithmic transparency, and user well-being.

WP2 provides a *foresight-driven roadmap* for the emergence of open, co-created, and human-centric Virtual Worlds, identifying the socio-technical trends and systemic risks that shape user trust and institutional adoption.
WP3, building upon these insights, translates foresight outcomes into ethical, legal, and governance frameworks, ensuring that privacy, inclusivity, and accountability are embedded in the design and operation of Virtual Worlds from the outset.

3.1 FROM WP2 FORESIGHT TO WP3 ETHICAL FRAMEWORKS

The foresight exercises conducted under WP2 identified privacy, safety, and governance trust as foundational conditions for Europe's vision of open Virtual Worlds. In particular, the *Roadmap for Open and Co-Created Virtual Worlds (D2.4)* emphasises *Trust and Safety by Design* as one of five strategic pillars. This pillar stresses that privacy, accountability, and user protection are not regulatory add-ons but design imperatives to be engineered into systems at the earliest stages.

Building on these insights, WP3 develops a comprehensive framework that translates the roadmap's normative intentions into actionable ethical and legal structures. The process involves three key transformations:

1. Anticipation → Regulation: Converting foresight-derived risks (e.g., biometric surveillance, content manipulation, inequitable access) into enforceable principles aligned with the GDPR, DSA, and AI Act.
2. Principles → Design: Embedding those principles in user-facing architectures—consent interfaces, accessibility dashboards, governance labels—that make compliance tangible.
3. Design → Governance: Establishing institutional mechanisms, including redress procedures and oversight channels, to sustain ethical assurance over time.

Through this pipeline, WP3 operationalises D2.4's foresight outputs, ensuring that *trust and safety* evolve from predictive insight to verifiable governance practice.

3.2 PRIVACY AND DATA PROTECTION IN IMMERSIVE ENVIRONMENTS

Virtual Worlds collect and process vast amounts of information from motion tracking and gaze detection to physiological and emotional cues, creating data ecosystems of unprecedented sensitivity. WP3's analysis identifies four interrelated domains where privacy and data protection become critical governance challenges.

3.2.1.1 Behavioural and Biometric Data Collection

XR interfaces, wearable sensors, and environmental mapping systems capture involuntary biometric signals that can reveal emotional or health-related information. While these enhance realism and

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responsiveness, they risk infringing on fundamental rights to privacy and bodily integrity. WP3 recommends implementation of privacy-preserving computation**,** on-device anonymisation**,** and revocable consent protocols to ensure continuous user control.

3.2.1.2 Data Ownership and Sovereignty

The transition to open Virtual Worlds demands decentralised data governance models. Building on WP2's foresight that identified *data portability and user sovereignty* as major adoption drivers, WP3 advocates for user-controlled data vaults and interoperable consent mechanisms, allowing individuals to migrate their digital identities and assets across platforms without losing ownership or control.

3.2.1.3 Algorithmic Transparency and Bias

AI-driven moderation, content curation, and behavioural analytics create new forms of algorithmic authority. Without oversight, these systems risk reproducing bias and opacity. WP3 aligns with the *AI Act's risk-based approach* and proposes the inclusion of algorithmic audit trails**,** human-in-the-loop oversight, and traceability standards to guarantee fairness and explainability in automated decision-making.

3.2.1.4 Jurisdictional and Cross-Border Enforcement

Virtual Worlds transcend national boundaries, creating ambiguities in liability and enforcement. WP2 foresight identified "regulatory fragmentation" as a growing threat to user trust. WP3 addresses this by proposing a layered governance model that integrates EU-level regulation with platform-specific ethical commitments, ensuring harmonisation without stifling innovation.

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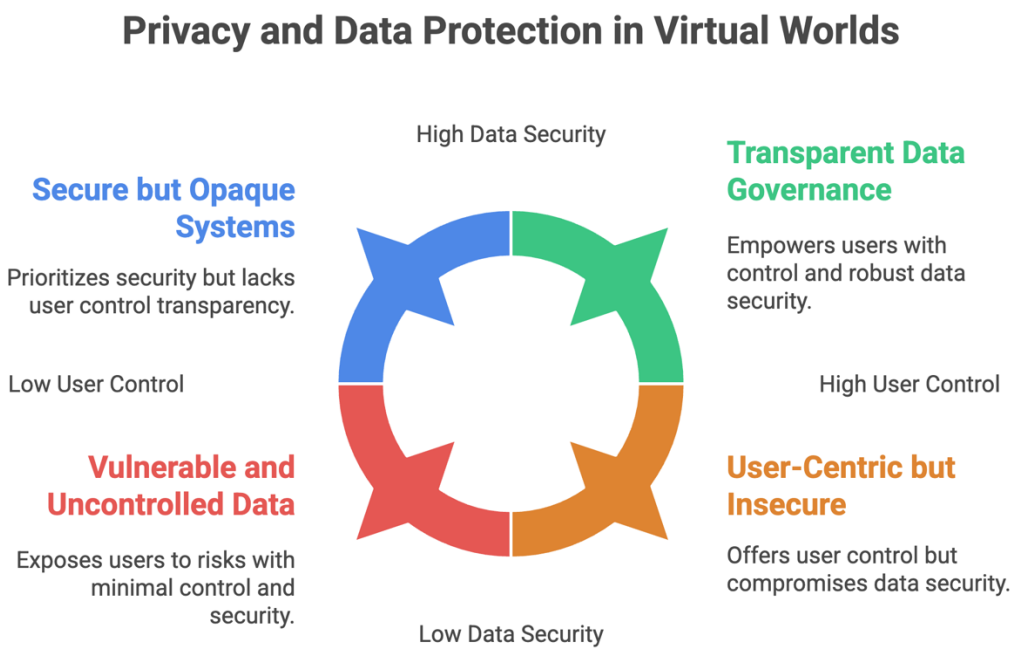

Figure 4: Privacy and Data Protection Typology in Virtual Worlds

Figure 3 illustrates four characteristic configurations of privacy and data-security trade-offs in Virtual Worlds. *Secure but Opaque Systems* prioritise technical protection but obscure user control; *Transparent Data Governance* combines security with empowerment; *User-Centric but Insecure* systems over-expose user data despite offering control; and *Vulnerable and Uncontrolled Data* environments exhibit both low control and low security. The OPENVERSE framework aims to transition from opaque or insecure states toward Transparent Data Governance, achieving both strong protection and meaningful user agency.

3.3 ETHICAL DIMENSIONS BEYOND DATA PROTECTION

Ethics in Virtual Worlds extends well beyond legal compliance. It encompasses psychological safety, digital identity, inclusivity, and the equitable distribution of benefits. WP3's framework identifies three domains where ethical foresight must be operationalised:

1. **Psychological and Cognitive Well-being**: Immersive experiences can induce motion sickness, sensory overload, or emotional distress. Ethical design must include comfort thresholds, time-use warnings, and adaptive interaction settings, a concept also discussed in D3.3 and D3.4 as determinants of trust and engagement.
2. **Identity, Authenticity, and Representation**: Avatars act as extensions of personal identity. WP3 underscores the right to pseudonymity, as confirmed by D3.4's findings that visible governance rather than enforced identification enhances trust.

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3. **Digital Equity and Accessibility**: WP2 foresees growing digital divides in XR adoption. WP3 integrates universal design principles, multilingual interfaces, and affordability metrics into its ethical architecture, ensuring inclusivity for diverse users and SMEs.

3.3.1.1 Embedding Machine-Assisted Ethical Oversight

In parallel, WP3 recognises that traditional static policies cannot govern dynamic, high-volume immersive ecosystems. Ethical oversight must itself be computationally scalable and context-aware. To this end, Tasks 3.4 and 3.5 are developing a Graph-RAG (Retrieval-Augmented Generation) framework that encodes ethical norms, legal obligations, and governance rules into a semantically structured knowledge graph. The system can retrieve, contextualise, and explain relevant obligations such as privacy clauses, inclusivity benchmarks, or IPR constraints during decision-making or audit events. This approach transforms ethics and governance into live, queryable infrastructure, allowing both human reviewers and automated agents to verify compliance, trace reasoning, and provide evidence-based justifications for governance actions.

3.4 TRANSLATING ETHICS INTO GOVERNANCE PRACTICE

D3.2 positions ethical principles as governance mechanisms that are traceable, measurable, and enforceable. The table below demonstrates how WP3 translates WP2 foresight into actionable governance levers and incorporates the emerging Graph-RAG system as a core accountability instrument.

Ethical Principle	Governance Mechanism (WP3 Implementation)	Linked WP2 Roadmap Element
Privacy & Autonomy	Consent dashboards, user-controlled data vaults, revocable authorisation	*Trust and Safety by Design*
Transparency	Algorithmic audit trails; explainable moderation; **Graph-RAG guidance** linking system behaviour to declared obligations	*Responsible AI & Content Provenance*
Accountability	Governance labels; grievance escalation; liability mapping; **machine-auditable traceability** via the WP3 Ethics & IPR Knowledge Graph	*Ambidextrous Governance*
Inclusivity	Accessibility standards, multilingual interaction layers, SME-friendly APIs	*Co-creation & Social Inclusion*
Well-Being	Comfort metrics, cognitive-load thresholds, exposure-time policies	*Human Factors and User Trust*

By aligning each ethical pillar with a governance artefact, WP3 ensures that foresight recommendations become enforceable criteria. The incorporation of the Graph-RAG infrastructure provides a continuous monitoring and decision-support layer for ethics, IPR, and governance compliance.

3.5 ETHICAL GOVERNANCE AS A CONTINUOUS AND ADAPTIVE PROCESS

WP2's *Foresight-in-the-Loop* principle envisions a governance model that evolves alongside technology. WP3 mirrors this adaptability by establishing a feedback cycle where insights from empirical experiments (D3.3 and D3.4) feed directly into the Graph-RAG knowledge base and inform subsequent policy refinement. As Virtual Worlds adopt generative AI, neural interfaces, and mixed-

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reality commerce, this system will allow ethical standards to update dynamically, maintaining relevance and traceability across future use cases. The result is an *ambidextrous governance ecosystem* agile enough to encourage innovation, yet anchored in transparent and accountable ethical reasoning.

3.6 SUMMARY AND OUTLOOK

Section 3 integrates WP2's anticipatory foresight with WP3's normative design to establish a coherent roadmap from risk prediction to ethical assurance. Privacy, transparency, and inclusivity emerge as interconnected governance dimensions that together constitute *Trust and Safety by Design*. Through the deployment of knowledge-graph and Graph-RAG infrastructures, ethics and governance become *machine-interpretable, auditable, and adaptive*. These developments lay the foundation for Task 3.4 (Ethical and Legal Requirements) and Task 3.5 (IPR and Governance Models), ensuring that the forthcoming frameworks are both evidence-based and computationally actionable.

By embedding foresight, ethical reasoning, and machine-readable governance into a single continuum, OPENVERSE advances Europe's ambition for human-centric, rights-preserving, and future-proof Virtual Worlds.

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4 GOVERNANCE AND STANDARDS

Effective governance is the structural backbone of open and human-centric Virtual Worlds. In the OPENVERSE framework, governance is not conceived merely as the enforcement of legal compliance but as an integrated process combining ethical design, regulatory alignment, and technical standardisation. Building upon WP2's foresight-based roadmap and the ethical-legal analysis developed in WP3 **(Section 3),** this section elaborates on how governance principles evolve into implementable standards and measurable trust indicators.

4.1 FROM ETHICAL PRINCIPLES TO GOVERNANCE STRUCTURES

WP2 foresight activities identified *fragmented governance* as one of the most significant barriers to Europe's leadership in Virtual Worlds. WP3 addresses this challenge by transforming the ethical pillars defined earlier, privacy, transparency, accountability, inclusivity, and well-being, into institutional and technical structures capable of harmonising behaviour across heterogeneous platforms. The resulting governance model is:

- **Layered:** combining EU-level regulatory frameworks (GDPR, DSA, AI Act) with community-level ethical codes and self-regulatory mechanisms.
- **Distributed:** ensuring that decision-making power and compliance monitoring are shared between central authorities, platform operators, and users themselves.
- **Transparent:** making the reasoning behind moderation, data use, and IPR management visible through explainable and traceable systems such as the Graph-RAG governance layer.

4.2 THE ROLE OF THE GRAPH-RAG ETHICAL GOVERNANCE LAYER

Tasks 3.4 and 3.5 establish the **Graph-RAG for Ethics, IPR, and Governance** as the operational core of WP3's governance architecture. The system encodes ethical norms, regulatory obligations, and intellectual-property relationships into a dynamic, machine-readable knowledge graph that supports retrieval-augmented reasoning.

In practical terms, the Graph-RAG layer:

1. **Maps and Links Regulatory Knowledge**: Integrating EU legislation, codes of conduct, and ethical guidelines into a unified semantic schema.
2. **Provides Contextual Decision Support**: Retrieving relevant clauses or precedents to assist platform administrators, auditors, and users during governance events (e.g., content disputes, data requests).
3. **Enables Traceable Compliance**: Maintaining a transparent record of ethical justifications and governance decisions for auditability and accountability.
4. **Facilitates Interoperable Standards**: Exposing machine-readable governance metadata that can interoperate with emerging European digital-identity, IPR, and safety standards.

This architecture transforms ethical and legal governance from static documentation into a living infrastructure that can evolve with technological change and policy refinement.

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4.3 ALIGNMENT WITH EMERGING EUROPEAN STANDARDS

WP3's governance strategy aligns closely with ongoing European standardisation efforts, ensuring coherence between the OPENVERSE framework and the wider policy ecosystem. Key areas of convergence include:

- **Data Governance and AI Transparency:** Incorporation of principles from the *Data Governance Act* and *AI Act* to ensure explainable and risk-proportionate AI use within Virtual Worlds.
- **Digital Identity and Interoperability:** Compatibility with *EUDI Wallet* and *eIDAS 2.0* initiatives for secure identity verification and cross-platform authentication.
- **Intellectual Property Rights (IPR):** Integration of FAIR-compliant metadata and traceable content-provenance standards, allowing creators to assert ownership within decentralised environments.
- **Accessibility and Inclusion:** Alignment with *EN 301 549*[1] and related accessibility norms to guarantee equitable participation.

WP3's deliverables (D3.4 - Ethical and Legal Requirements and D3.5 - Governance Models) will consolidate these alignments into actionable recommendations for EU-level standardisation bodies such as CEN/CENELEC and the **European AI Alliance**.

4.4 GOVERNANCE MATURITY AND EVALUATION FRAMEWORK

To ensure consistency and measurable progress, WP3 evaluates Virtual-World ecosystems across four dimensions:

1. **Ethical Readiness:** Existence of documented codes of conduct, consent protocols, and diversity policies.
2. **Technical Readiness:** Implementation of privacy-preserving and audit mechanisms (e.g., consent dashboards, Graph-RAG integration).
3. **Institutional Readiness:** Defined accountability structures, grievance mechanisms, and user-representation channels.
4. **Societal Readiness:** Evidence of inclusivity, accessibility, and cultural adaptability.

Each dimension will be associated with Key Governance Indicators (KGIs) derived from WP2 foresight metrics, enabling longitudinal tracking of progress across pilot studies and demonstration cases (notably D3.3 and D3.4).

4.5 INTERACTION BETWEEN WP2 AND WP3

Governance and standards development within WP3 rely directly on WP2's foresight outputs. The linkage operates through a *two-way adaptive process*:

[1] https://accessible-eu-centre.ec.europa.eu/content-corner/digital-library/en-3015492021-accessibility-requirements-ict-products-and-services_en

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- **Input from WP2:** Anticipated trends, risk factors, and adoption scenarios inform the prioritisation of governance themes, such as data trustworthiness, identity portability, and ethical interoperability.
- **Feedback from WP3:** Implemented governance artefacts and ethical-legal insights feed back into WP2's roadmap, refining the *Foresight-in-the-Loop* methodology for subsequent policy adaptation.

This integration ensures that governance standards are not static blueprints but living mechanisms continuously shaped by empirical evidence and social foresight.

4.5.1 Summary and Forward Outlook

Section 4 consolidates WP3's role in translating foresight and ethical principles into practical governance frameworks and interoperability standards. Through the deployment of the Graph-RAG**,** WP3 establishes a technical-normative infrastructure that enables transparency, accountability, and dynamic policy adaptation. The outcomes will directly inform:

- **D3.4 – Ethical and Legal Requirements:** Defining enforceable criteria and compliance indicators derived from the ethical framework.
- **D3.5 – Governance Models:** Developing standardised governance artefacts and proposing their integration into European standardisation processes.

Together, these activities advance the OPENVERSE vision of an open, accountable, and human-centric Virtual-World ecosystem, ensuring that governance evolves as both a *technological capability* and a *democratic commitment*.

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5 INTEGRATION OF DEMONSTRATION CASES (D3.3 AND D3.4) WITH TASKS 3.4 AND 3.5

The demonstration cases developed under **D3.3** and **D3.4** serve as empirical testbeds through which the theoretical and governance frameworks elaborated in **D3.2** are validated, refined, and operationalised. Both case studies provide complementary insights into technological, ethical, and behavioural aspects that directly inform the formulation of **Ethical and Legal Requirements (Task 3.4)** and the design of **Governance Models (Task 3.5)**. Together, they complete the translational loop between conceptual foresight (WP2), normative structure (D3.2), and applied validation (D3.3–D3.4).

5.1 D3.3: VIRTUAL WORLDS-ENABLED ROBOTICS

D3.3, led by VUB, investigates the intersection of Virtual Worlds and robotic collaboration, exploring how immersive digital environments enhance coordination, explainability, and safety in human-robot interaction (HRI). The study situates industrial robotics within a metaverse-like framework, examining the implications of extended-reality integration for trust, agency, and ethical accountability.

Key findings relevant to governance development include:

- **Human-in-the-Loop Control:** Demonstrates how transparent data flows and real-time feedback improve trust in automated systems—an insight translated into WP3's principle of *algorithmic transparency*.
- **Safety and Explainability Metrics:** Provides quantitative measures for operator trust and system reliability, which will inform ethical key-performance indicators (eKPIs) in Task 3.4.
- **Collaborative Decision Environments:** Highlights the value of distributed control, supporting WP3's argument for *layered governance* and *shared accountability structures*.
- **Data and IPR Implications:** Identifies ownership ambiguities in co-created virtual-robotic artefacts, directly feeding into Task 3.5's IPR and governance model development.

These insights are being encoded into the Graph-RAG Ethics and IPR Knowledge Graph, allowing the ethical parameters derived from robotics experiments such as explainability, safety, and co-creation rights to become machine-readable governance metadata. D3.3 therefore operationalises ethical foresight through real-world robotic experimentation, providing quantitative evidence that strengthens normative design.

5.2 SOCIAL AND ETHICAL DIMENSIONS OF VIRTUAL WORLDS

D3.4 examines the human-social and legal aspects of Virtual Worlds, with emphasis on privacy, identity, pseudonymity, and behavioural governance. The demonstration case analyses user experiences and perceptions in immersive environments to determine how trust, inclusivity, and ethical compliance manifest in practice.

Core findings feeding into WP3 tasks include:

- **Trust and Pseudonymity:** Shows that *visible governance,* clear rules, transparent data handling, and ethical signalling build trust more effectively than enforced identification. This informs the *transparency and accountability* criteria of Task 3.4.
- **User Perception of Ethical Safety:** Identifies comfort thresholds and privacy expectations, contributing to the *psychological well-being* dimension in WP3's framework.

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- **Diversity and Inclusion Metrics:** Provides empirical data on cultural and accessibility factors, reinforcing Task 3.4's focus on universal design and inclusivity.
- **Governance Preferences:** Reveals users' preference for participatory moderation models, guiding Task 3.5's exploration of *decentralised and community-driven governance structures*.

These qualitative and behavioural insights populate the Graph-RAG's human-centric ontology, enabling dynamic linkage between ethical principles (e.g., dignity, autonomy, non-maleficence) and the legal constructs of data protection, content moderation, and liability.

5.3 SYNERGISTIC ROLE OF DEMONSTRATION CASES IN THE GOVERNANCE FRAMEWORK

While distinct in focus, D3.3 and D3.4 are methodologically and conceptually interlinked:

Table 3: Role of D 3.3 & D3.4 in the Governance Framework

Dimension	D3.3 Robotics Case	D3.4 Social VR Case	Resulting Contribution to WP3 Tasks
Ethical Validation	Safety, transparency, explainability	Privacy, trust, inclusion	Empirical foundation for Task 3.4 ethical indicators
Data & IPR Context	Ownership of co-created robotic artefacts	Identity, authorship, representation	Input to Task 3.5 governance and IPR models
Human Agency & Autonomy	Human-in-the-loop control	Pseudonymity, behavioural freedom	Reinforces autonomy and accountability pillars
System Integration	Real-time XR control interfaces	Social-behavioural modelling	Provides use-case evidence for Graph-RAG schema design

This synergy ensures that governance models are grounded in empirical reality, not merely theoretical constructs. The two demonstration cases jointly form the evidentiary basis for the iterative refinement of the WP3 ethical-legal architecture.

5.4 FEEDING RESULTS INTO TASKS 3.4 AND 3.5

The integration of D3.3 and D3.4 into the broader WP3 workflow follows a structured process:

1. **Extraction of Ethical and Legal Indicators (→ Task 3.4):** Each demonstration produces validated metrics—safety thresholds, inclusivity measures, consent compliance rates, which are standardised into measurable ethical and legal requirements. These populate the *Ethical and Legal Requirements Catalogue,* forming the output of D3.4 (WP3).
2. **Translation into Governance Artefacts (→ Task 3.5):** Using the Graph-RAG, the extracted indicators are converted into semantic representations, governance labels, rights ontologies, and traceability links, forming the backbone of the *Governance Models and IPR Framework*.
3. **Feedback to WP2 Foresight Loop:** Empirical insights from D3.3 and D3.4 refine WP2's roadmap assumptions on user trust, ethics adoption, and regulatory harmonisation, thereby closing the foresight-governance feedback loop.

Through this process, D3.3 and D3.4 ensure that Tasks 3.4 and 3.5 are *evidence-driven, user-informed, and technically implementable*. The integration of empirical data into the Graph-RAG establishes a continuous pipeline from experimentation to governance.

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5.5 SUMMARY

D3.3 and D3.4 provide the empirical roadmap upon which WP3's technical models are built.

- **D3.3** validates ethical principles in a *technological and industrial context* (human-robot collaboration).
- **D3.4** validates them in a *social and behavioural context* (user interaction and trust).

Together, they enable WP3 to transform ethics into a governance ontology codified within the Graph-RAG that informs Tasks 3.4 and 3.5 and ultimately supports the European Roadmap for Human-Centric Virtual Worlds defined in WP2.

These linkages ensure that OPENVERSE governance is *not prescriptive but adaptive,* grounded in empirical validation, formalised through interoperable standards, and continuously refined through the foresight-to-governance cycle.

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6 CONCLUSIONS

This deliverable, **D3.2 – Report on Challenges and Governance**, consolidates the foundational analysis for Work Package 3 by establishing the ethical, legal, and governance principles that underpin the OPENVERSE framework. It synthesises insights from WP2 foresight activities with the emerging evidence from demonstration cases (D3.3 and D3.4), translating them into a structured basis for the definition of ethical and legal requirements (Task 3.4) and governance models (Task 3.5).

At its core, D3.2 reaffirms that trust, transparency, and accountability are not peripheral considerations but structural enablers of Europe's ambition to lead the development of open, inclusive, and sustainable Virtual Worlds.

- **Conceptual Clarity:** D3.2 defines what constitutes a *Human-Centric Virtual World (HCVW)*—an environment where ethical design, transparency, and inclusivity are embedded in architecture rather than retrofitted post-development.
- **Ethical-Legal Framework:** It provides a comprehensive synthesis of privacy, data protection, and ethical considerations grounded in European values, building on WP2's *Trust and Safety by Design* and *Foresight-in-the-Loop* pillars.
- **Governance Architecture:** It proposes a layered governance model integrating regulation, ethics, and design, operationalised through measurable governance artefacts and key governance indicators (KGIs).
- **Graph-RAG:** Tasks 3.4 and 3.5 introduce the *Graph-RAG for Ethics, IPR, and Governance* as a novel infrastructure enabling machine-readable, adaptive, and explainable ethical governance across Virtual Worlds. This system connects legal obligations, ethical principles, and user rights within a traceable, queryable semantic framework.
- **Empirical Integration through Demonstration Cases:** D3.3 (Virtual Worlds-Enabled Robotics) and D3.4 (Social VR Case) provide complementary datasets that validate and enrich WP3's normative architecture, ensuring that ethical governance remains empirically grounded.
- **Cross-Work Package Synergy:** The feedback loop between WP2 foresight and WP3 governance design ensures that policy planning and technical standardisation evolve in parallel, guaranteeing long-term coherence between anticipation, experimentation, and regulation.

Following D3.2, WP3 activities will focus on transforming the conceptual and analytical outputs into implementable, testable, and standardisable instruments:

- **Ethical and Legal Requirements:** Will formalise the principles identified here into *Ethical and Legal Requirements,* defining measurable indicators, user-safety metrics, and audit criteria aligned with EU directives and emerging standards.
- **Governance Models:** Develop interoperable *Governance and IPR Models*, integrating them with the Graph-RAG to enable automated compliance monitoring, provenance tracking, and ethical reasoning in real-time virtual environments.

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7 REFERENCES

1. **Fernandez, P., & Hui, T.** (2022). *Life, the Metaverse and Everything: An Overview of Privacy, Ethics and Governance in Virtual Worlds.* arXiv:2204.01441.

2. **Zallio, M., Ohashi, N., & Clarkson, P. J.** (2023). *Designing the Metaverse: Scoping Review on Inclusive, Safe, and Trustworthy Extended Reality Ecosystems.* arXiv:2301.10010.

3. **Hasan, A.** (2023). *Governance and the Metaverse: Legal Frameworks, Regulatory Gaps, and Multi-Stakeholder Accountability.* SSRN.

4. **Maloney, D., Freeman, G., Robb, A., & Bruckman, A.** (2021). *It is Complicated: The Ethics of Social Virtual Reality Research.* arXiv:2108.11958.

5. **Tariq, F., et al.** (2023). *Deepfake in the Metaverse: Security, Threats, and Implications for Virtual Workspaces and Immersive Social Platforms.* arXiv:2305.xxxx.

6. **Ogunsan, K., & Iseoluwa, A.** (2025). *Regulating the Metaverse: Jurisdiction, Privacy, and Digital Inequality in Immersive Environments.* ResearchGate.

7. **European Commission.** (2023). *An EU Initiative on Web 4.0 and Virtual Worlds: A Head Start in the Next Technological Transition.* COM(2023) 442 final..
8. **European Parliament and Council.** *General Data Protection Regulation (GDPR)*, Regulation (EU) 2016/679.

9. **European Parliament and Council.** *Digital Services Act (DSA)*, Regulation (EU) 2022/2065.

10. **European Parliament and Council.** *Data Governance Act (DGA)*, Regulation (EU) 2022/868.

11. **European Commission / Council.** *Artificial Intelligence Act* (political agreement text, 2023–2024).

12. **ISO 9241-210:2019.** *Ergonomics of Human-System Interaction – Human-Centred Design for Interactive Systems.*

13. **European Accessibility Act**, Directive (EU) 2019/882; EN 301 549 v3.2.1.

14. **eIDAS 2.0 / European Digital Identity Regulation.** Regulation (EU) No 910/2014 (as amended).

15. **ENISA – European Union Agency for Cybersecurity.** (2023). *Cybersecurity of Extended Reality and Virtual Environments.*

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