



3DxVERSE

Work Package 4

D4.1: Digital Commons Framework - First Report

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List of abbreviations and acronyms

Abbreviation	Meaning
AI	Artificial Intelligence
AI Act	The AI Act (Regulation (EU) 2024/1689)
API	Application Programming Interface
BI	Business Intelligence
CDR	Corporate Digital Responsibility
CEF	Connecting Europe Facility
CSDD	Corporate Sustainability Due Diligence (Directive 2024/1760)
CSR	Corporate Social Responsibility
DAOs	Decentralized Autonomous Organizations
DC	Digital Common
DCF	Digital Commons Framework
DPI	Digital Public Infrastructure
DPO	Data Protection Officer
DSA	Digital Services Act
DT	Digital Twin
EC	European Commission
EDIC	European Digital Infrastructure Consortium
EIB	European Investment Bank
ERDF	European Regional Development Fund
EU	European Union
G20	Group of 20
GDPR	General Data Protection Regulation (EU) 2016/679
GPL	General Public License
GraphQL	Graph Query Language
HRIAs	Human Rights Impact Assessments
HTTP	Hypertext Transfer Protocol
IETF	Internet Engineering Task Force
IoT	Internet of Things
MIMs	Minimal Interoperability Mechanism
OASC	Open & Agile Smart Cities
PPPs	Public-Private Partnerships
PSA	Privacy & Security Assessment
PU	Public
R&D	Research and Development
REST	Representational state transfer
ROI	Return on Investment
SROI	Social Return On Investment
UN	United Nations
VR/XR	Virtual / eXtended Reality
W3C	World Wide Web Consortium
WCAG	Web Content Accessibility Guidelines
WP	Work package including the task description of ethical requirements

EXECUTIVE SUMMARY

This document constitutes **Deliverable D4.1 – First Report on the Digital Commons Framework (DCF)** of the **3DxVERSE project**. Its purpose is to present a structured and principled approach to the realisation and operationalisation of **Digital Commons**, while ensuring full adherence to **ethical** and **legal** standards. The DCF provides a conceptual and practical foundation that supports the development, governance, and sustainability of Digital Commons within the project and beyond.

The **Digital Commons Framework** defines a set of core principles, conceptual models, and practical guidelines designed to ensure legal compliance, ethical integrity, and high-quality implementation. In addition, it outlines governance mechanisms that allow flexibility in the distribution of roles and responsibilities, thus enabling adaptable and context-sensitive configurations of Digital Commons.

The framework encompasses key elements such as:

- **(a)** The identification and articulation of foundational principles, norms, and values.
- **(b)** Practical guidelines for the implementation and alignment of Digital Commons with the DCF.
- **(c)** Metrics designed to assess both the operational effectiveness of the DCF and the broader impact of the Digital Commons initiatives.
- **(d)** Financial strategies aimed at enabling sustainable realisation, exploitation, and innovation within the Digital Commons.

The DCF is intended to be applied to the **Local Digital Twins (LDTs)** developed during the course of this project. Following implementation, a validation phase will assess its relevance, effectiveness, and adaptability, thereby informing its refinement and future applications.

Structure of the Deliverable

Chapter 1 – Introduction

This chapter provides a concise overview of the 3DE project, outlines the objectives of the deliverable, and introduces key concepts including digital responsibility, digital commons, and the foundational elements of the DCF.

Chapter 2 – Ethical and Legal Framework

This section details the ethical principles and legal obligations underpinning the DCF. It offers guidance on aligning Digital Commons activities with existing legal frameworks and ethical standards, reinforcing the project's commitment to responsible digital development.

Chapter 3 – Metrics and Impact Assessment

A comprehensive set of metrics is introduced to evaluate both the operational performance of the DCF and the societal, economic, and environmental impact of Digital Commons. Metrics are organised under thematic domains such as **Digital Inclusion**, **Economic Resilience**, and **Sustainability**.

Chapter 4 – Financial Strategies

This chapter explores various financial requirements and outlines strategic approaches to securing funding for the implementation and scaling of Digital Commons. It presents potential funding sources, investment models, and long-term financial sustainability mechanisms.

Chapter 5 – Conclusions and Next Steps

The final chapter summarises the key findings and structural components of the deliverable. It also outlines the next steps in the evolution of the Digital Commons Framework, including its application, validation, and further development in **Deliverable D4.2**.

1. INTRODUCTION

1.1. Introduction to 3DxVERSE

The 3DxVERSE project aims to harness the potential of Digital Twins to foster sustainable travel and living communities. The initiative focuses on key use cases at various levels, from airports to living communities, encompassing sustainability, economic growth, societal development, safety, security, resilience, and corporate sustainability responsibility in a holistic approach. By establishing interoperable Digital Twins and leveraging cutting-edge technologies like AI, XR/VR and Data Spaces, this project aligns with the New European Bauhaus initiative and the G20 Framework for Systems of Digital Public Infrastructure. Through potential collaboration with organisations like the International Data Spaces Association, Open & Agile Smart Cities (OASC) working on the OASC Minimal Interoperability Mechanisms (MIMs), and European Digital Infrastructure Consortia (EDIC's), we seek to create a transformative impact on digital inclusion, innovation, and sustainability, contributing to the achievement of the 2030 Agenda for Sustainable Development, see reference (30). By creating an open, interoperable, secure, trustworthy, fair and inclusive reference implementation blueprint digital twin for EU citizens, businesses and public administrations, this project strives to build a resilient, inclusive, and environmentally conscious digital economy and society. The focus on societal impact, economic growth, and sustainability reflects our commitment to achieving the Sustainable Development Goals and shaping Europe's digital future. The project involves collaboration with global partners, including Amsterdam, Rotterdam, Almelo, Enschede, Aruba, Hamburg and can scale to global collaboration with partner countries, including Africa, India, Singapore, Japan, UK, and Canada.

1.2. Introduction to Digital Commons Framework

The term commons historically refers to resources that are collectively owned or shared among communities. These include natural resources like air, water or grazing lands. Resources which are not privately owned but are managed collectively and used by many. Elinor Ostrom, Nobel Laureate in Economics, pioneered the understanding of how communities can successfully govern such shared resources through cooperative arrangements, norms, and rules without needing top-down regulation or privatization, see reference (37).

In the digital age, this concept has evolved into what we now call **Digital Commons**. This refers to shared digital resources—such as open-source software, open data, public algorithms, online platforms, or collaborative knowledge systems like Wikipedia—that are governed collectively by communities of users, developers, and stakeholders, see reference (7). Similarly to commons, Digital commons require principles to ensure that digital infrastructure and resources serve the public interest rather than solely commercial or private goals.

Digital commons differ from commercial platforms in that they are designed to empower users and communities to co-create, govern, and benefit from the digital ecosystem, see reference (3). Rather than being passive consumers of technology, users of digital commons are often active participants in decision-making, development, and maintenance processes. This participatory nature makes digital commons an important model for creating inclusive, equitable, and sustainable digital futures.

In the context of the 3DxVERSE project and the CitiVerse ambitions, see reference (11), this document, the Digital Commons Framework (DCF), builds on this foundation. It translates these ideas into practical and operational structures for developing and maintaining citizen-centric, ethically grounded digital infrastructure. The DCF is not only about creating shared technology—it is about fostering shared responsibility, values, and governance for the digital environments we live in.

This document, the Digital Commons Framework (DCF), mainly relies on the developments in the field of (Corporate) Digital Responsibility (CDR), a relatively novel concept building on Corporate Social Responsibility (CSR). Within these fields there has been extensive research and practical applications. The standards, principles and guidelines from the CDR and CSR literature form the foundation of the DCF combined with the recent developments in the field of Data/Digital Commons, Digital Twins, Digital Public Infrastructure and AI.

As digital technologies – Digital Twin, DPI, AI and XR/VR- become more deeply embedded in every aspect of society, the need for responsible and ethical approaches to their design, deployment, and governance grows increasingly urgent. This has led to the emergence of Corporate Digital Responsibility

(CDR) as a guiding framework for organisations seeking to balance technological innovation with social accountability.

CDR provides a structured approach to aligning digital activities—such as data management, software development, and platform governance—with societal values, such as fairness, inclusivity, transparency, and sustainability. It extends beyond traditional corporate social responsibility by addressing the unique challenges posed by digital technologies, including issues related to data ethics, algorithmic bias, accessibility, and digital inclusion.

Importantly, CDR resonates with broader movements such as **Industry 5.0**, see reference (33), which focuses on placing human values and wellbeing at the centre of technological progress. It also aligns with principles found in **Tech for Good**, see reference (35), **Digital Rights advocacy**, see reference (34), and **Ethics by Design**, see reference (36)—all of which emphasise the importance of designing digital systems that serve public interest, empower communities, and ensure equitable access.

For the development of the Digital Commons Framework, CDR offers a practical and future-oriented foundation. It reinforces the idea that digital commons should not only be open and shared, but also ethically governed, socially inclusive, and sustainable over time. In doing so, it supports a digital infrastructure that is trusted, participatory, and resilient. Qualities that are essential for the long-term success of any shared digital environment.

The Digital Commons Framework is a conceptual framework and an actionable plan, providing guidance in the development, exploitation and continuous improvement of Digital Commons. The framework is designed not only for digital commons within the 3DxVERSE project, but for any future application.

Context

The European Union aims to promote an inclusive and sustainable CitiVerse, see reference (11), setting leading benchmarks for equality, openness, decentralized governance, sustainability, and well-being. The CitiVerse must be designed and developed on decentralized, technology-agnostic, open, user-centric, and accessible platforms, reflecting the values, principles, and fundamental rights of the EU.

The aim is to create citizen-centric environments where consumers, workers, and creators are respected, and European businesses can thrive, scale, and grow. It should offer opportunities to public authorities and urban planners to better serve their citizens and meet larger societal purposes such as climate change and biodiversity, as well as make use of evidence-based decisions using Web 4.0 technology. Open standards and interoperability between networks and platforms are essential to ensure user freedom, digital ownership, cross-platform activities, and economic opportunities. Competition and innovation among providers need to be sustained for CitiVerse ecosystems to become more diverse and richer.

The DCF sets standards and provides guidance for any citizen-centric digital environment. This document prescribes how the DC from the citizen and user should be applied in the project. In other words, the Digital Commons Framework document defines how Digital Twins will be developed and used in the project.

The DCF is including:

- Principles
- Guidelines and activities
- Governance mechanisms
- Metrics
- Financial Strategies

The 3DxVERSE Digital Commons Framework document sets out and defines the principles that form the foundation for any technology developed in the 3DxVERSE project. The underlying principles, see table 1, follow from an SLR conducted in the 3DxVERSE project. The DCF comprises a set of guidelines, activities and procedures, to consider in the design and exploitation phase of the technical work in the project, with the aim to ensure that the work and results of the 3DxVERSE project are of a uniformly high standard.

Table 1 : List of Principles in the Digital Commons Framework

Principle	Description
Democratic Governance	Digital commons should be governed through democratic and participatory models, ensuring community members can co-create rules and decisions. Such governance fosters trust, accountability, and adaptability by reflecting shared values and enabling diverse voices to shape outcomes, see references (1), (3), (4), (7), (22).
Legal Compliance	Digital commons must comply with existing legal frameworks, including data protection, intellectual property, AI regulations, and cybersecurity laws. Legal compliance safeguards communities, ensures accountability, and protects the long-term viability of commons-based models, see references (2), (10), (12), (13), (14), (18), (25), (28), (32)
Human Rights	Digital commons must uphold and protect fundamental human rights in the digital space. These include rights to privacy, freedom of expression, non-discrimination, and participation in digital life, as recognized in international and EU digital rights frameworks, see references (15), (17) and (29).
Accessibility	Digital commons must be accessible to all, regardless of ability, language, literacy, or digital skill level. Accessibility ensures that barriers—technical, cognitive, social, or economic—are proactively addressed, enabling equitable participation and aligning with both ethical values and legal obligations see references (3), (4), (27).
Fairness	Fairness ensures that all individuals are treated equitably in access, participation, and outcomes. It includes non-discrimination, fair data practices, balanced labour structures, and protection against algorithmic bias or exclusion in digital systems, see references (4), (8), (9), (20), (21), (26), (27)
Inclusion & participation	Everyone should have the opportunity to meaningfully engage in the design, use, and governance of digital commons. This principle emphasizes diverse representation, community involvement, and the active inclusion of underrepresented voices. Participation must be supported through transparency, trust, and opportunities for co-creation across all stages of a Digital Common’s lifecycle, see references (3), (4), (7), (22), (24), (27).
Sustainability	Digital commons should minimise environmental impact and promote responsible use of resources. Governance must account for the ecological footprint of digital infrastructure and explore ways to support green innovation and long-term environmental stewardship, see references (3), (7), (8), (9), (21), (22), (27)
Data Privacy & Security	Respect for data privacy is essential in the design and operation of digital commons. Individuals must retain control over their personal data, with transparent policies, strong safeguards, and compliance with legal standards that protect privacy rights and

	data sovereignty, see references (3), (4), (7), (9), (20), (21), (24).
Open-Source	Open-source approaches promote collaboration, transparency, and shared ownership. By making code and knowledge freely accessible, digital commons can foster innovation, enable collective improvement, and align with principles of openness and community governance, see references (3), (6), (19)
Transparency	Transparency builds trust by making decision-making, data use, and system operations open and understandable. Digital commons should clearly communicate governance processes, platform impacts, and technical details, including open access to source code where relevant, see references (3), (4), (5), (9), (19), (20), (21), (26), (27)

1.3. Purpose of the deliverable

The DCF is delivered as part of WP4 and serves as a guideline and reference to enable the successful development and exploitation of Digital Twin and Digital Public Infrastructure technology achieving the project objectives with the highest quality. As digital commons aim to be inclusive, open, and community-driven, their governance must align with fundamental principles such as fairness, transparency, privacy, human rights, and democratic participation — while also complying with relevant legal and regulatory standards.

This deliverable translates those principles into a structured set of values, norms, and actionable guidelines that can be applied across different stages of technology design, implementation, and use. It serves as a reference for all partners and stakeholders involved inside and outside the project, ensuring that the digital commons created are not only technologically robust, but also socially legitimate, legally compliant, and ethically sound.

More than a static document, this deliverable initiates a broader conversation on how digital infrastructures can be reimagined—not as extractive systems controlled by a few, but as collectively governed resources that serve the public interest. It invites experimentation, critical reflection, and co-creation, paving the way for a new paradigm in digital governance.

Deliverable D4.1 is a first report and will be complemented by the end of the project with lessons-learned, D4.2 Final Digital Commons Framework.

1.4. Status of the deliverable

This deliverable is a first report meaning that it forms the foundation of the DCF. The information used in the deliverable is both theoretical and practical but was not validated in practice. Also, as the project is in the early stages, and there have not been any technological advancements this report includes conceptual ideas which will be further developed during M6-M30 of the 3DxVERSE project.

1.5. Intended audience

The dissemination level of D4.1 is 'public' (PU) and it is available to the members of the consortium, the European Commission (EC) services and those external to the project.

This document serves as an internal guideline and reference for all 3DxVERSE beneficiaries, especially of technology providers. While the DCF's purpose extends beyond providing guidance in DCs for this project, its full potential will be realized in D4.2 once the framework is validated.

2. ETHICAL AND LEGAL FRAMEWORK

2.1. Introduction

This chapter lays the foundation for the ethical and legal governance of Digital Commons within the 3DxVERSE project. As the development of Digital Commons intersects with sensitive societal domains — such as data privacy, digital rights, inclusivity, and sustainability — a robust framework is essential to ensure that these systems are aligned with European and National values and legal standards from the outset.

First the core ethical principles that underpin the Digital Commons Framework (DCF), such as **inclusiveness, transparency, fairness, democratic governance**, and respect for **human rights** are discussed. These principles serve as normative anchors that guide the design, implementation, and use of digital commons technologies throughout their lifecycle.

In parallel, the chapter outlines how these ethical considerations are supported and enforced through relevant legal frameworks, including the General Data Protection Regulation (GDPR), see reference (32), the Digital Services Act (DSA), see reference (14), and the AI Act, see reference (2). Together, these regulations define boundaries and obligations for responsible innovation in the digital space.

Practical guidelines are provided to support the operationalisation of these principles within different types of digital commons, ensuring adaptability across contexts while preserving the integrity of the framework. These guidelines are intended to help project partners and stakeholders navigate complex ethical and legal terrains while co-creating trustworthy, participatory, and sustainable digital infrastructures.

A crucial component of the DCF is governance—not only in terms of structure and decision-making efficiency, but as an ethical concern that determines how power is distributed, who participates, and how transparency and accountability are upheld. Governance mechanisms shape whether a digital commons lives up to its promise of being community-driven and socially legitimate.

To that end, 2.4 introduces and contrasts centralized and decentralized governance models. These models are especially relevant for digital commons, where ethical governance must be internal to the system, not merely externally imposed.

2.2. Digital Ethics

Ethics lies at the heart of the Digital Commons Framework—not as an external requirement or compliance checkbox, but as the foundational compass guiding how digital commons are conceived, governed, and sustained. In the context of 3DxVERSE, ethics refers to the continuous reflection on what is fair, just, and responsible in the development and deployment of technology. It is about asking not only what is legally permissible or technically possible, but what is the right thing to do, for whom, and under what circumstances.

This ethical reflection is grounded in long-standing principles from moral and political philosophy, such as justice (ensuring fair treatment and equitable access), autonomy (respecting individuals' right to make informed choices), beneficence (acting to promote societal good), and human dignity (recognizing the inherent worth of all individuals). These principles are not static rules but evolving reference points that help communities navigate the complex social, cultural, and technological questions that arise in digital innovation.

Digital commons, by their nature, require a different approach to governance than commercial platforms or centralized public infrastructures. They are community-owned, decentralized, and participatory systems, see reference (3) and (7), which means that traditional top-down forms of regulation and compliance are insufficient on their own. In such environments, what holds the system together is not just a legal framework or a set of technical standards, but a shared ethical commitment among participants. Ethics becomes the basis for building mutual trust, fostering inclusivity, and ensuring long-term legitimacy.

In this light, the question arises: if digital commons are guided by strong ethical principles, do we still need to rely so heavily on rigid standards, certifications, or regulatory templates? This deliverable proposes that rather than rejecting standards altogether, we must see them as downstream tools—useful for implementation but not substitutes for ethical reasoning. In other words, ethical reflection should shape the standards, not the other way around.

This ethics-first approach encourages communities to be proactive rather than reactive. It supports a model of governance that evolves with the needs and values of its users, rather than one that retrofits responsibility only when legal requirements demand it. Especially in rapidly changing fields such as AI, XR, and digital identity, such flexibility is essential. Ethics helps communities anticipate potential harms, balance competing values, and make decisions that are not just safe or lawful, but also meaningful and just.

The principles presented in the next section are derived from this ethical foundation. They are not intended as static rules but as living commitments—anchored in human rights, civic responsibility, and the aspiration to build digital systems that serve people and communities. In doing so, we hope to encourage a wider conversation about how decentralized digital infrastructures can move beyond compliance to cultivate cultures of care, accountability, and shared digital stewardship. This decentralized ethics first approach will be embedded in the 3DxVERSE' Digital Commons.

2.3. Underlying Principles

At the core of the Digital Commons Framework (DCF) lies a set of foundational principles that embody the ethical, legal, and social values needed to guide the development and governance of trustworthy digital commons. The underlying principles were formed through an extensive Systematic Literature Review. These principles are not standalone; they are interdependent and together form a robust structure for ensuring responsible innovation, inclusivity, and human-centred technology.

To illustrate the role and relationship of these principles, we developed the House of Digital Commons. In figure 1, the principles are positioned like building blocks of a house, where each layer—from human rights and legal compliance to transparency, sustainability, and participation—supports the overall stability and integrity of the digital environment.

At the heart of this structure lies human-centred technology, which connects and depends on all the surrounding elements to be ethically aligned, legally compliant, and socially beneficial. This chapter introduces each of these underlying principles, along with corresponding guidelines, to help shape digital commons that are resilient, fair, and future proof.

2.3.1. House of Digital Commons

The House of Digital Commons includes ten fundamental principles focussed on Human-centric Technology. Digital Commons are designed and act responsibly to protect, engage and empower users and non-users. People are behind all stakeholder groups, therefore Digital Commons, and the technology it consists of, are designed and deployed according to the ten Human-centred principles. Figure 1 represents the House of Digital Commons.

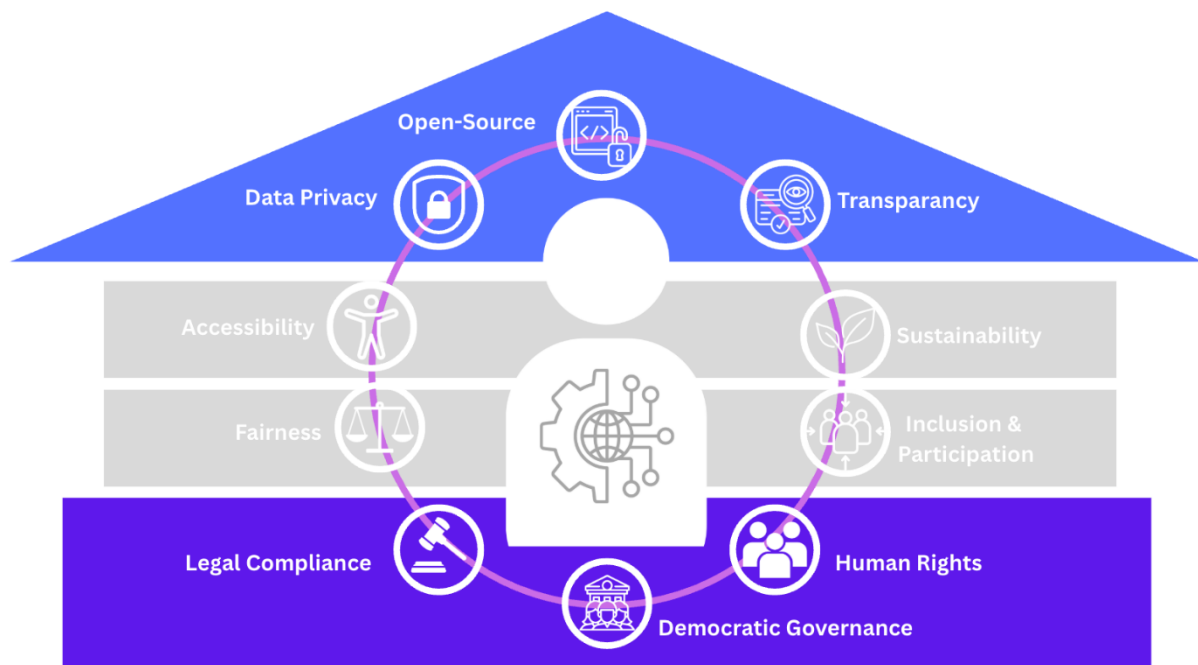


Figure 1: The House of Digital Commons

The “House of Digital Commons” visualizes the layered structure of values and principles that collectively support ethical, resilient, and community-centered digital infrastructures. Each layer of the house carries a distinct meaning and role, emphasizing that ethical and legal governance is not a single principle but an integrated, multi-dimensional foundation for responsible digital development.

At the base of the house, we find Legal Compliance, Human Rights, and Democratic Governance. These foundational elements establish the normative floor—rooted in law, civic freedom, and collective decision-making—upon which any digital common must be built. They represent the minimum conditions for fairness, legitimacy, and societal accountability in digital systems.

The middle layer includes Fairness, Accessibility, Sustainability, and Inclusion & Participation—principles that ensure the commons remain open, equitable, and socially just. These values help operationalize the rights and governance frameworks above by making digital systems welcoming, adaptable, and usable for all members of society, especially marginalized communities.

The top of the house is made up of Data Privacy & Security, Open-Source, and Transparency—principles that create trust and accountability through openness, control, and verifiability. Positioned in the “roof,” they protect the integrity of the commons from above, ensuring that the systems remain secure, community-controlled, and understandable.

Surrounding all of these is the central commitment to human-centered technology, depicted at the heart of the structure. This reminds us that the entire digital commons must ultimately serve people—not markets, algorithms, or institutions—and that technology should be developed with empathy, ethics, and empowerment at its core.

This architectural metaphor shows that (digital) ethics is not a checklist but a living structure: the stability of the commons depends on the balance and strength of all its parts. If one layer is neglected—whether legal rights, inclusivity, or transparency—the whole house becomes fragile. Thus, ethics must be embedded in every layer and decision, shaping both the foundations and the future of digital commons.

Table 2: List of Principles of the House of Digital Commons

Principle	Description
Democratic Governance	Digital commons should be governed through democratic and participatory models, ensuring community members can co-create rules and decisions. Such governance fosters trust, accountability, and adaptability by reflecting shared values and enabling diverse voices to shape outcomes, see references (1), (3), (4), (7), (22).
Legal Compliance	Digital commons must comply with existing legal frameworks, including data protection, intellectual property, AI regulations, and cybersecurity laws. Legal compliance safeguards communities, ensures accountability, and protects the long-term viability of commons-based models, see references (2), (10), (12), (13), (14), (18), (25), (28), (32)
Human Rights	Digital commons must uphold and protect fundamental human rights in the digital space. These include rights to privacy, freedom of expression, non-discrimination, and participation in digital life, as recognized in international and EU digital rights frameworks, see references (15), (17) and (29).
Accessibility	Digital commons must be accessible to all, regardless of ability, language, literacy, or digital skill level. Accessibility ensures that barriers—technical, cognitive, social, or economic—are proactively addressed, enabling equitable participation and aligning with both ethical values and legal obligations see references (3), (4), (27).
Fairness	Fairness ensures that all individuals are treated equitably in access, participation, and outcomes. It includes non-discrimination, fair data practices, balanced labour structures, and protection against algorithmic bias or exclusion in digital systems, see references (4), (8), (9), (20), (21), (26), (27)
Inclusion & participation	Everyone should have the opportunity to meaningfully engage in the design, use, and governance of digital commons. This principle emphasizes diverse representation, community involvement, and the active inclusion of underrepresented voices. Participation must be supported through transparency, trust, and opportunities for co-creation across all stages of a Digital Common’s lifecycle, see references (3), (4), (7), (22), (24), (27).
Sustainability	Digital commons should minimise environmental impact and promote responsible use of resources. Governance must account for the ecological footprint of digital infrastructure and explore ways to support green innovation and long-term environmental stewardship, see references (3), (7), (8), (9), (21), (22), (27)
Data Privacy & Security	Respect for data privacy is essential in the design and operation of digital commons. Individuals must retain control over their personal data, with transparent policies, strong safeguards, and compliance with legal standards that protect privacy rights and data sovereignty, see references (3), (4), (7), (9), (20), (21), (24).

Open-Source	Open-source approaches promote collaboration, transparency, and shared ownership. By making code and knowledge freely accessible, digital commons can foster innovation, enable collective improvement, and align with principles of openness and community governance, see references (3), (6), (19)
Transparency	Transparency builds trust by making decision-making, data use, and system operations open and understandable. Digital commons should clearly communicate governance processes, platform impacts, and technical details, including open access to source code where relevant, see references (3), (4), (5), (9), (19), (20), (21), (26), (27)

2.3.2. Guidelines & Activities

The table below provides a preliminary list of guidelines and activities that are considered in 3DxVERSE to ensure the Digital Commons overall quality on the identified principles. The guidelines are grouped based on the underlying principle.

Table 3: Preliminary Guidelines & Activities

Principle	Guideline or Activity	Description
Inclusion & participation	Community Involvement	<ul style="list-style-type: none"> Maintain open communication channels and provide regular updates on project progress. Create forums and workshops to gather input from various stakeholders.
	Diverse Representation	<ul style="list-style-type: none"> Ensure that all community groups, especially underrepresented voices, are included in decision-making processes.
	Focus Groups	<ul style="list-style-type: none"> Conduct focus groups with diverse community members to gather diverse feedback and suggestions.
	Stakeholder Analysis	<ul style="list-style-type: none"> Perform a stakeholder analysis to identify and engage all relevant parties (e.g. perform outreach campaigns)
	Co-Creation Workshops	<ul style="list-style-type: none"> Organize workshops where community members can collaboratively design and develop aspects of the digital commons.
Accessibility	Universal Design	<ul style="list-style-type: none"> Implement design principles that cater to all users, regardless of their abilities.
	Barrier Identification	<ul style="list-style-type: none"> Regularly assess and address technical, cognitive, social, and economic barriers.
	Compliance with Standards	<ul style="list-style-type: none"> Adhere to international accessibility standards such as WCAG.

	Accessibility Audits	<ul style="list-style-type: none"> • Conduct regular audits to ensure compliance with accessibility standards.
	User Testing	<ul style="list-style-type: none"> • Involve users with diverse abilities in testing to identify and rectify accessibility issues.
	Training Sessions	<ul style="list-style-type: none"> • Provide training for developers and designers on accessibility best practices. • Provide training, information and user guides to users.
Democratic Governance	Accountability Mechanisms	<ul style="list-style-type: none"> • Implement mechanisms to hold decision-makers accountable.
	Shared Values	<ul style="list-style-type: none"> • Ensure that governance reflects the shared values of the community.
	Governance Meetings	<ul style="list-style-type: none"> • Hold regular meetings where community members can voice their opinions and vote on decisions.
	Surveys and Polls	<ul style="list-style-type: none"> • Use surveys and polls to gather input on governance issues
	Reporting	<ul style="list-style-type: none"> • Publish regular reports on governance activities and decisions
	Participatory Models	<ul style="list-style-type: none"> • Establish governance structures that allow for community participation in decision-making.
Data Privacy & Security	Data Control	<ul style="list-style-type: none"> • Ensure individuals retain control over their personal data. • Individuals can easily remove (personal) data. • All uploaded and used data is removed with the removal of personal accounts; unless specifically agreed upon.
	Transparent Policies	<ul style="list-style-type: none"> • Develop and communicate clear data privacy policies • Ensure access logs to provide transparency into who accesses the data and when...
	Strong Safeguards	<ul style="list-style-type: none"> • Implement robust security measures to protect data. • Appoint a Data Protection Officer • Use encryption methods for collected data

	Privacy Impact Assessments	<ul style="list-style-type: none"> • Conduct assessments to identify and mitigate privacy risks.
	Data Protection Training	<ul style="list-style-type: none"> • Provide training on data protection practices for all stakeholders
	Regular Audits	<ul style="list-style-type: none"> • Perform regular audits to ensure compliance with data privacy regulations.
	Privacy and Security Assessment (PSA)	<ul style="list-style-type: none"> •
Sustainability	Minimize Environmental Impact	<ul style="list-style-type: none"> • Implement practices that reduce the ecological footprint of digital infrastructure. • Use (local) renewable energy. • Use energy efficient Technology. • Reduce (energy) waste
	Green Innovation	<ul style="list-style-type: none"> • Support and invest in green technologies and practice
	Long-Term Stewardship:	<ul style="list-style-type: none"> • Plan for the long-term sustainability of digital commons
	Energy Audits	<ul style="list-style-type: none"> • Conduct audits to identify and reduce energy consumption.
	Sustainable Procurement	<ul style="list-style-type: none"> • Source materials and services from sustainable providers (e.g. CSDD) • Local sourcing where applicable.
	Environmental Awareness Campaigns	<ul style="list-style-type: none"> • Run campaigns to raise awareness about sustainability practices. • Regularly communicate the environmental impact of functions and actions, and individuals' total yearly impact.
Fairness	Non-Discrimination	<ul style="list-style-type: none"> • Ensure equitable treatment in access, participation, and outcomes
	Fair Data Practices	<ul style="list-style-type: none"> • Implement practices that prevent data bias and ensure fairness. • Conduct algorithmic bias audits (e.g., using IBM Fairness 360).

	Bias Audits	<ul style="list-style-type: none"> Regularly audit systems for algorithmic bias and take corrective actions Evaluate AI/ML models for discrimination
	Inclusive Policies	<ul style="list-style-type: none"> Develop and enforce policies that promote inclusivity and fairness.
	Training Programs	<ul style="list-style-type: none"> Provide training on non-discrimination and fair practices.
Transparency	Public Forums	<ul style="list-style-type: none"> Host public forums to discuss and review project activities.
	Open-Source Repositories	<ul style="list-style-type: none"> Maintain open repositories for all project-related code and documentation Communicate Sensitive data, and why this is protected
	Clear Communication	<ul style="list-style-type: none"> Clearly communicate governance processes, platform impacts, and technical details.
	Open Decision-Making	<ul style="list-style-type: none"> Make decision-making processes open and accessible (User-council)
	Open Access	<ul style="list-style-type: none"> Provide open access to Digital Common Provide open access to source code and other relevant information.
	Transparency Reports	<ul style="list-style-type: none"> Publish regular reports detailing decision-making processes and outcomes.
Legal Compliance	Adherence to Laws	<ul style="list-style-type: none"> Ensure compliance with relevant legal frameworks, including data protection, intellectual property, and cybersecurity laws (GDPR, AI Act, Cyber Resilience Act). Partner with (Digital) Rights NGO's (e.g., EFF, Access Now)
	Regular Reviews	<ul style="list-style-type: none"> Conduct regular reviews to stay updated with legal requirements.
	Clear Policies	<ul style="list-style-type: none"> Develop clear policies that outline compliance requirements Use standardized open licenses (e.g., GPL, Creative Commons)

	Compliance Audits	<ul style="list-style-type: none"> • Perform regular audits to ensure adherence to legal standards. • Regularly update policies to reflect changes in legal requirements.
	Legal Training	<ul style="list-style-type: none"> • Provide training on legal compliance for all stakeholders • Regularly reinforce training or tests to ensure compliance by users.
Human Rights	Human Rights Assessments	<ul style="list-style-type: none"> • Align with UN Guiding Principles on Business and Human Rights see reference (23). • Conduct assessments to identify and address human rights risks. • Implement human rights impact assessments (HRIAs)
	Awareness Campaigns	<ul style="list-style-type: none"> • Run campaigns to raise awareness about (digital) rights to all stakeholders
	Grievance Mechanisms	<ul style="list-style-type: none"> • Establish mechanisms for reporting and addressing human rights violations • Establish crisis response protocols • Establish processes to identify human rights injustices
	Non-Discrimination	<ul style="list-style-type: none"> • Promote non-discrimination and equal participation in digital life.
Open-Source	Open by Default	<ul style="list-style-type: none"> • Use Open-Source Technology • Make Open-Source the default approach for projects. • Ensure transparency in the development process • Provide thorough documentation for open-source projects
	(Community) Collaboration	<ul style="list-style-type: none"> • Build and support open-source communities • Encourage contributions to open-source projects. • Encourage “forking” and reuse of existing project
	Interoperability	<ul style="list-style-type: none"> • Use standardized protocols (e.g., HTTP, ActivityPub, OpenAPI) instead of proprietary formats. • Follow W3C, IETF, or IEEE standards where applicable. • Build systems with APIs (REST, GraphQL) and plugin architectures to allow third-party extensions.

2.4. Governance Mechanism

Governance mechanisms are central to the integrity, trustworthiness, and resilience of digital commons. In the context of the Digital Commons Framework (DCF), governance is not merely a matter of structure or efficiency—it is a fundamental ethical concern. How decisions are made, who gets to participate, how transparent those processes are, and whether power is distributed fairly all determine whether a digital common lives up to the principles of democratic governance, inclusion, and human-centered design.

Digital commons require governance systems that are not only functional but also normatively aligned with the values outlined in the House of Digital Commons: transparency, accountability, participation, and legal and human rights compliance. These principles are not optional add-ons but foundational to ensuring that digital technologies serve the communities they are meant to support—especially in a commons model, which is inherently citizen-driven and community-owned.

To explore how these principles can be embedded into practice, we distinguish between two broad categories of governance mechanisms—centralized and decentralized—while recognizing that hybrid models are also possible. The DCF aims to remain applicable beyond the 3DxVERSE project, so understanding both models helps us evaluate which mechanisms best align with the values and operational realities of different digital commons contexts. Importantly, within 3DxVERSE, we intend to test the viability of decentralized governance through practical experiments, including the use of Decentralized Autonomous Organizations (DAOs), to assess their ability to operationalize ethics through technical infrastructure.

Centralized Governance

Centralized governance refers to a model where decision-making authority resides within a single entity or a small leadership group. This approach can ensure streamlined coordination, enforce uniform policies, and provide clear lines of accountability.

In a digital commons with centralized governance, a board, steering committee, or core team typically holds authority over key aspects such as resource allocation, platform development, and rule enforcement. While this can enhance efficiency and clarity, it often comes at the cost of inclusivity and democratic legitimacy.

Advantage	Disadvantage
Efficiency: Decisions can be made quickly and implemented without the need for extensive consultation.	Lack of Inclusivity: Stakeholders may feel excluded from the decision-making process.
Clear Accountability: It's easier to identify who is responsible for decisions and actions.	Potential for Misuse of Power: Concentrating authority in a small group increases the risk of decisions that benefit a few at the expense of the majority.
Consistency: Policies and processes are uniformly applied, reducing the risk of deviations or inconsistencies.	

Table 4: centralized Governance

Decentralized Governance (DAO)

Decentralized governance distributes decision-making authority across a wider group of stakeholders. It shifts from top-down control to collaborative stewardship, often supported by digital tools like blockchain and smart contracts. A prominent implementation of this model is the Decentralized Autonomous Organization (DAO), where governance rules are transparently encoded and automatically executed, see reference (31) for further details.

Decentralized models align more closely with the ethical foundation of the DCF. They embody democratic governance, promote active inclusion, and enhance transparency by design. More than a technical solution, decentralization offers a way to “bake ethics into infrastructure”—a concept echoed in digital ethics literature (e.g., Latour, 1992; Nissenbaum, 2001) that argues technologies are not neutral, but shape and reflect social norms.

Advantage	Disadvantage
Inclusivity: All stakeholders have a voice in decision-making, fostering a sense of ownership and participation.	Complexity: Decentralized governance can be more complex to implement and manage.
Transparency: Decisions and processes are often more transparent, reducing the risk of corruption or favoritism.	Slower Decision-Making: Consensus-building among a large group can take time, potentially slowing down the implementation of decisions.
Resilience: The distributed nature of governance can make the system more resilient to disruptions.	Coordination Challenges: Ensuring that all stakeholders are aligned and informed can be difficult.

Table 5: Decentralized Governance

In a centralized model, ethical principles like fairness and transparency must be externally monitored and enforced. In contrast, decentralized governance offers the potential to internalize ethics—embedding principles like participation and accountability into the technical design of the system itself. For instance, open voting mechanisms, transparent treasury systems, or community-elected roles can ensure governance reflects collective values rather than institutional mandates.

In the 3DxVERSE project, we aim to implement and evaluate a DAO prototype as part of our digital commons infrastructure. This will allow us to explore how decentralized governance can not only facilitate ethical alignment but also foster greater community engagement, trust, and legitimacy. By experimenting with such models in practice, we contribute to an emerging field of socio-technical innovation that seeks to redefine governance as a participatory, transparent, and resilient process—rather than a static hierarchy.

2.5. Conclusion

This chapter has outlined the foundational concepts that underpin the Digital Commons Framework (DCF), offering a conceptual lens through which digital resources can be developed, managed, and sustained in a way that prioritizes the public good. Digital commons are more than shared digital infrastructures—they are socio-technical ecosystems built on values such as openness, participation, accountability, and collective ownership.

We introduced the House of Digital Commons as a metaphor and structuring model, highlighting how the framework is composed of interconnected ethical and governance layers. Central to this model is the belief that ethical considerations—such as human rights, democratic governance, transparency, and data privacy & security—are not external standards to be checked off, but intrinsic values that must be designed into the very architecture of digital systems. These values provide a normative foundation upon which technical and legal standards can be meaningfully interpreted and applied.

Furthermore, governance is a key operational dimension of digital commons. We explored centralized and decentralized governance mechanisms, emphasizing how decentralized approaches such as DAOs can help operationalize core ethical principles through participatory and transparent processes. While both governance models have their place depending on context, our ambition within the 3DxVERSE project is to test and evaluate decentralized governance mechanisms in practice, and in doing so, explore how governance itself can serve as an ethical infrastructure.

Ultimately, the DCF aims to support the development of digital commons that are not only technically sound and legally compliant, but above all ethically grounded and democratically governed. This foundation is essential if we want to build digital systems that empower communities, safeguard rights, and contribute to a more just and sustainable digital future.

3. METRICS & IMPACT ASSESSMENT

3.1. Introduction

As Digital Commons emerge as critical infrastructure for a fair and democratic digital future, it becomes imperative to measure their real-world impact. Without rigorous and transparent evaluation, the principles embedded in the Digital Commons Framework—such as inclusivity, sustainability, and democratic governance—risk remaining aspirational rather than actionable.

This chapter outlines how we can assess the effectiveness, accountability, and transformative potential of both the framework itself and the digital commons that implement it. Through a structured approach to metrics and impact assessment, we aim to ensure that Digital Commons not only function technically but also deliver meaningful societal outcomes.

3DxVERSE focused on key areas (see table 6)—such as digital inclusion, innovation, economic resilience, community skilling, and environmental sustainability—not only because they reflect widespread policy and societal priorities, but also because they correspond with the ethical principles embedded in the Digital Commons Framework, including fairness, accessibility, transparency, and long-term sustainability.

By embedding impact assessment as a core component of the Digital Commons Framework, this chapter bridges the gap between values and verification, turning abstract principles into measurable practices that can guide continuous improvement and policy alignment.

Table 6: Overview of key areas

Area	Description
Digital Inclusion	Assesses the extent to which diverse groups within society can access and benefit from digital resources.
Innovation	Evaluates how Digital Commons contributes to technological advancements and process improvements.
Economic Resilience	Measures the impact of Digital Commons on economic stability and adaptability.
Community Digital Skilling	Tracks the contribution of Digital Commons to community and workforce skill enhancement and readiness.
Accessibility & Inclusivity	Measures the accessibility and inclusivity of Digital Commons for a diverse user base.
Governance Effectiveness	Evaluates the effectiveness of governance structures within Digital Commons.
Environmental Sustainability	Evaluates the environmental impact of Digital Commons and their contributions to sustainable development.
User Engagement & Satisfaction	Measures user participation and satisfaction with Digital Commons services and resources.
Data Quality & Utilization	Tracks the accuracy, reliability, and utility of data within Digital Commons.
Economic Efficiency	Assesses cost-effectiveness and resource utilization within Digital Commons operations.
Resilience & Adaptability	Evaluates the ability of Digital Commons to adapt to challenges, such as cyber threats or changing user needs.

Knowledge Sharing & Collaboration	Measures the extent of knowledge exchange and cooperative initiatives fostered by Digital Commons.
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3.2. Metrics

In the realm of Digital Commons, assessing the impact and efficacy of various initiatives is paramount to ensure the equitable distribution of digital resources and foster innovation. The metrics developed for this purpose offer a structured approach to evaluating key areas such as digital inclusion, technological innovation, economic resilience, and workforce skilling. By systematically measuring these aspects, the Digital Commons Framework can adapt and evolve to meet the dynamic needs of society, while promoting sustainable and inclusive growth.

Digital Inclusion

Digital Inclusion assesses the extent to which diverse groups within society can access and benefit from digital resources.

Metric	Description
Percentage of users with disabilities accessing Digital Commons	<ul style="list-style-type: none"> Measure through user surveys and platform analytics to identify the number of users with disabilities utilizing accessibility features.
Number of multilingual resources available	<ul style="list-style-type: none"> Monitor the addition of resources in various languages through content management systems and user feedback.
Percentage of users with different ethnic background	<ul style="list-style-type: none"> measure the percentage of users using a different language and benchmark this to demographic data.
Gender and age diversity among active users	<ul style="list-style-type: none"> Use demographic data collected during user registration and participation statistics to determine diversity metrics. Benchmark against available public demographic data
Equity of access across socioeconomic groups	<ul style="list-style-type: none"> Survey users and analyze access statistics to ensure services are reaching all socioeconomic groups equitably.
Percentage of use	<ul style="list-style-type: none"> Measure the percentage of users by dividing the accounts created and logged in at least once, twice etc.

Table 7: Digital Inclusion Metrics

Innovation

For innovation we evaluate how Digital Commons contributes to technological advancements and process improvements.

Metric	Description
Number of new applications or solutions developed	<ul style="list-style-type: none"> Track the development and deployment of new applications through project management tools and developer reports
Frequency of updates to digital infrastructure	<ul style="list-style-type: none"> Monitor the rate of software and hardware updates
Rate of adoption of new technologies	<ul style="list-style-type: none"> Dividing the number of users using new technologies by the total user group. Compare with adoption rate of other new technologies

Table 8: Innovation Metrics

Economic Resilience

Measures the impact of Digital Commons on economic stability and adaptability.

Metric	Description
Reduction in operational costs for organizations	<ul style="list-style-type: none"> Analyze financial statements and cost reports and compare with project not utilizing Digital commons
Success rate of community/urban planning projects	<ul style="list-style-type: none"> Track the number and funding amounts of projects where Digital Commons are used compared to success rate of projects without the use of Digital Commons
Reduction of time in project processes	<ul style="list-style-type: none"> Benchmark the time used for urban planning projects with the implementation of Digital Commons compared to without its use.

Table 9: Economic Resilience Metrics

Community Digital Skilling

Within Community Digital Skilling the contribution of Digital Commons to community and workforce skill enhancement and readiness is tracked.

Metric	Description
Number of training programs offered	<ul style="list-style-type: none"> Monitor the number of programs listed on the platform and participation rates
Improvement of user engagement	<ul style="list-style-type: none"> Track used functionality per user over time
Increase in employability of trained individuals	<ul style="list-style-type: none"> Survey participants and track employment outcomes post-training.
Participants' digital competence	<ul style="list-style-type: none"> Assess the improvement in participants' digital skills through self-assessment surveys

Table 10: Community Digital Skilling Metrics

Accessibility and Inclusivity

Measures the accessibility and inclusivity of Digital Commons for a diverse user base.

Metric	Description
Adoption rates of accessibility features	<ul style="list-style-type: none"> Analyze platform usage data to determine the adoption rates of these features. Compare statistic with users with disabilities.
Number of accessibility complaints (resolved)	<ul style="list-style-type: none"> Track complaints and resolution times through customer support systems
Engagement rates from marginalized groups	<ul style="list-style-type: none"> Survey engagement and participation metrics from these groups.
User satisfaction with inclusivity measures	<ul style="list-style-type: none"> Collect and analyze user feedback on inclusivity through surveys and focus groups.

Task Completion Rate	<ul style="list-style-type: none"> Percentage of users who successfully complete specific tasks (for example during registration).
Time on Task	<ul style="list-style-type: none"> Time it takes users to complete tasks compared to average benchmarks
Error rate	<ul style="list-style-type: none"> Number of errors or issues encountered during use derived from user logs

Table 11: Accessibility & Inclusivity Metrics

Governance Effectiveness

Evaluates the effectiveness of the governance mechanisms and structures within Digital Commons.

Metric	Description
Percentage of stakeholder participation in decision making	<ul style="list-style-type: none"> Monitor attendance and participation records from meetings or responses to surveys.
Compliance rates with established guidelines	<ul style="list-style-type: none"> Use compliance audits and reports to track adherence to guidelines.
Community satisfaction with governance processes	<ul style="list-style-type: none"> Collect feedback through surveys and community meetings.
Frequency and resolution times for governance disputes	<ul style="list-style-type: none"> Track dispute logs and resolution times.

Table 12: Governance Effectiveness Metrics

Environmental Sustainability

Evaluates the environmental impact of Digital Commons and their contributions to sustainable development.

Metric	Description
Monitor energy consumption of digital systems	<ul style="list-style-type: none"> Measure energy usage before and after implementing Digital Commons, including energy used for data Management systems.
Carbon footprint impact from initiatives	<ul style="list-style-type: none"> Use carbon accounting tools to estimate emissions of using digital commons in urban planning and other use cases, compared to projects without DC.

Table 13: Environmental Sustainability Metrics

User Engagement and Satisfaction

Measures user participation and satisfaction with Digital Commons services and resources.

Metric	Description
Active user retention rates	<ul style="list-style-type: none"> Monitor user activity logs to track returning users over time.
Average time spent using Digital Commons	<ul style="list-style-type: none"> Analyze session duration data from user interactions.
User satisfaction scores from surveys	<ul style="list-style-type: none"> Collect and analyze data from user satisfaction surveys

Table 14: User Engagement & Satisfaction Metrics

Data Quality and Utilization

Tracks the accuracy, reliability, and utility of data within Digital Commons.

Metric	Description
Percentage of verified and validated datasets	<ul style="list-style-type: none"> Conduct regular data audits to verify and validate datasets.
Frequency of data updates and refreshes	<ul style="list-style-type: none"> Monitor data update logs to track the frequency of updates.
Number of datasets used for research, applications, or services	<ul style="list-style-type: none"> Track dataset usage by monitoring download and access logs.
Percentage of datasets adhering to quality standards	<ul style="list-style-type: none"> Conduct quality assessments based on predefined standards

Table 15: Data Quality & Utilization Metrics

Economic Efficiency

Assesses cost-effectiveness and resource utilization within Digital Commons operations.

Metric	Description
Cost savings achieved through shared digital infrastructure	<ul style="list-style-type: none"> Compare total costs of projects with and without implementing Digital Commons
Return on investment (ROI) for projects	<ul style="list-style-type: none"> Calculate ROI by comparing project costs to financial benefits derived
Efficiency of resource allocation	<ul style="list-style-type: none"> Monitor resource usage and allocation metrics.
Average cost per user for accessing services	<ul style="list-style-type: none"> Divide total operational costs by the number of active users.

Table 16: Economic Efficiency Metrics

Resilience and Adaptability

Evaluates the ability of Digital Commons to adapt to challenges, such as cyber threats or changing user needs.

Metric	Description
Recovery time after system outages or breaches	<ul style="list-style-type: none"> Track the duration of system downtimes and time taken for recovery.
Percentage of systems compliant with cybersecurity standards	<ul style="list-style-type: none"> Conduct regular cybersecurity audits to ensure compliance.
Frequency and effectiveness of updates	<ul style="list-style-type: none"> Monitor the frequency of system and software updates
User satisfaction with system reliability	<ul style="list-style-type: none"> Collect user feedback regarding the reliability of systems.

Table 17: Resilience & Adaptability Metrics

Knowledge Sharing and Collaboration

Measures the extent of knowledge exchange and cooperative initiatives fostered by Digital Commons.

Metric	Description
Number of collaborative projects initiated	<ul style="list-style-type: none"> Track the initiation and progress of collaborative projects.
Number of cross-sector partnerships formed	<ul style="list-style-type: none"> Record and track the formation of partnerships across different sectors.
Satisfaction ratings for collaboration opportunities	<ul style="list-style-type: none"> Collect feedback from participants on collaboration experiences

Table 18: Knowledge Sharing & Collaboration Metrics

3.3. Tools & Methodologies

To effectively measure these metrics, the following tools and methodologies are recommended:

- **Survey Platforms:** Utilize for collecting user feedback on inclusivity, accessibility, and satisfaction.
- **Data Analytics Tools:** Employ platforms such as Tableau or Power BI for visualizing trends and analyzing large datasets.
- **Impact Assessment Frameworks:** Implement frameworks such as the Social Return on Investment (SROI) to quantify societal benefits.
- **Automation Tools:** Use automated data collection through APIs and IoT devices for real-time tracking.
- **Benchmarking Databases:** Leverage existing datasets to compare performance against industry standards.

3.4. Conclusion

The metrics and impact assessment outlined in this document serve as a vital component of the Digital Commons Framework. By systematically evaluating digital inclusion, innovation, economic resilience, and digital workforce skilling, the metrics ensures that the framework is both theoretically robust and practically effective. The collaborative efforts of all stakeholders will be essential in shaping a digital future that upholds the values of inclusivity, sustainability, and human-centricity.

By implementing these metrics and recommendations, we can establish best practices in digital commons and contribute to a more connected and resilient global community. The focus on transparent and iterative assessment will provide valuable insights and drive continuous improvement, ensuring that the Digital Commons Framework meets its objectives and delivers tangible benefits to society.

4. FINANCIAL MODELS

4.1. Introduction

Digital Commons represent shared digital resources that are collectively managed and maintained by a community. To ensure their long-term viability, robust funding mechanisms are essential. Unlike traditional (infrastructure) projects, Digital Commons require ongoing investment in software development, community management, cybersecurity, and the platform’s operational costs.

The methodology for assessing the financial requirements involves a comprehensive analysis of current and projected expenses necessary to sustain Digital Commons initiatives. This includes evaluating costs associated with infrastructure, development, operational support, and potential risks. The expected outcomes of this assessment are to establish a clear understanding of both short-term and long-term funding needs, and to develop strategic funding models that can adapt to the evolving nature of digital commons.

4.2. Assessment of Financial Requirements

To develop sustainable funding strategies for future Digital Commons, it is essential to understand both initial investment and operational costs. Given the high diversity of Digital Commons and the absence of any established Digital Commons in this project thus far, the final report, due in M30, will offer detailed insights based on findings and developments up to that point. This report will integrate experiences and lessons learned from the ongoing project(s), enabling more refined recommendations and strategies.

A template has been created to track costs during the creation of various Digital Commons, as well as the expected operational costs. Costs are categorized into personnel costs, infrastructure, community engagement, platform operation, and other relevant expenses. This will form a solid foundation for analyzing the short-term and long-term financial requirements necessary for developing sustainable funding strategies.

Additionally, the assessment will consider potential revenue streams and funding sources, such as grants, donations, and partnerships with private and public sectors. Identifying and leveraging these sources will be critical to ensuring the longevity and success of Digital Commons initiatives.

By providing a comprehensive understanding of financial requirements and potential funding models, this report aims to support the development of resilient and adaptable Digital Commons that can thrive in an ever-evolving digital landscape.

4.3. Funding Sources

There are numerous options for funding Digital Commons, ranging from municipal grants to private partnerships. However, prioritization from local governments is essential to ensure that funding is specifically allocated for Digital Commons initiatives. The following options present potential opportunities that could fit or warrant further investigation.

4.3.1. Local Level

Public Funding Sources

Type	Description
Municipal Grants & Subsidies	Many cities and towns offer funding for open-source initiatives, smart city projects, and digital inclusion programs.
Local Economic Development Funds	Funding allocated by local governments to support digital infrastructure and community-based projects.

Public Procurement & Contracts	Local governments may contract Digital Commons services for open data platforms or public digital services.
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Table 19: Local Public Funding Sources

Private Funding Sources

Type	Description
Local Businesses & Corporate Social Responsibility (CSR) Programs	Companies may support digital commons projects as part of their commitment to community development
Local Philanthropic Foundations	Charities and civic organizations may offer grants for projects promoting digital inclusion.
Community Crowdfunding	Platforms like GoFundMe or local fundraising campaigns to support digital commons.

Table 20: Local Private Funding Sources

4.3.2. Regional Level

Public Funding Sources

Type	Description
Regional Development Funds	Funding from regional government agencies for digital innovation, infrastructure, and sustainability.
Smart City & Digitalization Grants	Some regions provide targeted funding for digital transformation and participatory governance
Interregional Cooperation Programs	EU-funded programs supporting digital projects across different regions (e.g. Interreg).

Table 21: Regional Public Funding Sources

Private Funding Sources:

Type	Description
Regional Innovation Hubs & Accelerators	Funding from regional business hubs that support digital entrepreneurship.
Public-Private Partnerships (PPPs)	Collaboration with private investors for funding large-scale Digital Commons projects.
Chambers of Commerce & Regional Business Networks	Some regional business organizations offer grants or investments in digital solutions

Table 22: Regional Private Funding Sources

4.3.3. National Level

Public Funding Sources

Type	Description
National Government Grants	Ministries of Economic Affairs, Digitalization, or Innovation often provide funding for digital public infrastructure and open data projects.
Public Research Funds	National research organizations and universities often fund Digital Commons-related R&D.
Tax Incentives & Subsidies	Some governments provide tax relief or direct subsidies for digital sustainability projects.
National Open Data & Digital Transformation Programs	Specific programs to promote government transparency and digital accessibility.

Table 23: National Public Funding Sources

Private Funding Sources

Type	Description
National Venture Capital & Investment Funds	Investment in open-source and digital innovation startups.
Private Foundations & Think Tanks	Organizations that support digital rights, privacy, and commons-based projects.
Technology Companies (e.g., Google.org, Microsoft AI for Good)	Funding programs from large tech companies supporting open digital ecosystems.

Table 24: National Private Funding Sources

4.3.4. European Level

Public Funding Sources

Type	Description
Horizon Europe	The EU's key funding program for research and innovation, supporting digital commons and open technology.
Digital Europe Programme	EU program funding digital transformation, AI, and cybersecurity initiatives.
Connecting Europe Facility (CEF)	Supports the development of digital public infrastructure, including open data and interoperability projects.
European Regional Development Fund (ERDF)	Funds regional digitalization projects and smart infrastructure.
Interreg Europe	Supports cross-border cooperation on digital and innovation projects.
European Investment Bank (EIB) Loans & Grants	Funding for large-scale digital infrastructure projects.
EU Open Data Initiatives & Public Procurement	Direct funding for digital public services and open-source solutions.

Table 25: European Public Funding Sources

Private Funding Sources

Type	Description
Corporate Venture Funds & Tech Accelerators	EU-based corporate funding programs for open-source and Digital Commons innovation.
European Philanthropic Foundations	Grants for digital inclusion and commons-based governance (e.g., Open Society Foundations, European Cultural Foundation).
Impact Investment Funds	Investments in ethical and sustainable digital projects e.g., European Social Innovation Fund, Gaia-X).

Table 26: European Private Funding Sources

4.4. Funding Strategies

Ensuring long-term financial sustainability for Digital Commons requires a structured, multi-source funding approach. Unlike commercial digital platforms that operate with profit-driven models, Digital Commons are inherently community-driven, open, and public-interest-oriented. However, for financial sustainability Digital Commons cannot solely rely on subsidies and grants from public organizations. This distinct nature necessitates funding mechanisms that do not solely rely on public- or market-based revenues but instead integrate diverse financial strategies to support development, operation, and maintenance.

A hybrid funding model is essential to address the unique financial challenges of Digital Commons. This model balances short-term operational costs with long-term sustainability by leveraging multiple revenue streams, including direct and indirect value capture, asset utilization, community-driven contributions, and policy-based institutional support. By combining these approaches, Digital Commons projects can remain resilient and adaptable, ensuring continued impact beyond their initial funding cycles.

The following sections outline the core funding strategies applicable to Digital Commons, detailing how they contribute to financial sustainability and how they can be effectively integrated.

4.4.1. Core Funding Strategies

Direct Value Capture

Direct value capture generates revenue by establishing voluntary or low-cost financial contributions from users and stakeholders. While Digital Commons often operate on an open-access basis, certain financial mechanisms can be introduced to support their sustainability without compromising inclusivity.

One approach involves implementing usage-based fees, where premium features or additional services require a small financial contribution. This model allows the core offering to remain free while ensuring that additional functionalities, such as expanded storage or API access, contribute to long-term maintenance costs. Alternatively, membership and subscription models encourage voluntary financial support from users who benefit from the commons, similar to the donation-driven approach of Wikipedia.

Another effective strategy is public service partnerships, where governmental institutions integrate Digital Commons solutions into their digital infrastructure. Under this model, governments provide financial support in exchange for access to high-quality, open digital resources that enhance public services. Additionally, impact fees and levies can be imposed on organizations that directly benefit from the existence of Digital Commons, ensuring that their financial contributions reflect the value they derive from these shared digital assets.

The advantage of direct value capture is its ability to establish predictable revenue streams, thereby reducing reliance on external funding sources. However, its effectiveness depends on user willingness to contribute and the perceived value of premium offerings.

Indirect Value Capture

Indirect value capture refers to funding mechanisms that monetize the broader economic benefits generated by Digital Commons without imposing direct costs on users. This strategy is particularly relevant for large-scale Digital Commons initiatives, where the surrounding economic ecosystem benefits from publicly available digital resources.

A key example of this approach is real estate value uplift, where municipalities collect financial contributions from businesses or property owners whose assets increase in value due to proximity to a Digital Commons project. This model has been successfully applied in smart city projects, where digital infrastructure investments indirectly boost economic activity in surrounding areas.

Another form of indirect value capture involves monetization of open data. While Digital Commons often prioritize free access to information, aggregated and anonymized data insights can be licensed to research institutions, businesses, and policymakers. This approach ensures that data-driven innovation remains accessible while providing a revenue stream to sustain the commons.

Additionally, public-private partnerships (PPPs) can serve as a mechanism for indirect value capture. By fostering collaboration between governments, research institutions, and private-sector organizations, PPPs create shared investment opportunities where financial contributions are tied to long-term economic and social benefits.

This funding approach aligns well with the broader economic impact of Digital Commons, ensuring that financial contributions come from entities that derive value from their existence rather than placing the burden on individual users.

Asset Utilization and Recycling

Many Digital Commons projects manage digital or physical infrastructure that can be monetized to support financial sustainability. Asset utilization strategies leverage existing resources to generate revenue while maintaining accessibility.

One approach is leasing digital infrastructure to third parties. For example, cloud hosting or secure storage solutions developed within Digital Commons can be offered to external organizations for a fee, creating a self-sustaining funding stream. Similarly, revenue securitization can be used, where projected future income from Digital Commons services is leveraged as collateral to raise funding through financial instruments.

Another strategy involves establishing data and knowledge-sharing hubs, where specialized training programs, consultancy services, and certification courses generate income while promoting the adoption of Digital Commons principles. These initiatives provide valuable skills and resources to participants while ensuring that revenue generated is reinvested into maintaining the commons.

Asset utilization is particularly effective in reducing reliance on external grants, as it enables Digital Commons to generate internal financial resources that can support their ongoing development and expansion.

Community-Driven and Crowdsourced Funding

As community-led initiatives, Digital Commons can benefit from direct financial contributions from users, developers, and supporters. Crowdsourced funding mechanisms leverage the collective interest of stakeholders to ensure long-term sustainability.

Crowdfunding campaigns offer a decentralized approach to financial support, where users voluntarily contribute to project development. Platforms such as Gitcoin and OpenCollective facilitate funding for open-source initiatives, demonstrating how decentralized finance models can sustain digital commons.

Similarly, cooperative ownership models distribute financial responsibility among multiple stakeholders, ensuring that those who benefit from the commons also play a role in its maintenance.

Emerging technologies such as tokenization and digital currencies provide new opportunities for community-driven funding. Blockchain-based ecosystems enable transparent and decentralized financial contributions, where users can receive incentives for their participation in maintaining the commons.

Additionally, structured volunteer and contributor support programs can be established to encourage skilled professionals to contribute time and expertise, with tax-deductible incentives for their work. These programs not only provide financial relief but also strengthen community engagement and governance.

Policy and Institutional Support

Governmental and institutional funding plays a crucial role in ensuring long-term stability for Digital Commons. Public sector involvement provides structural financial support and integrates commons-based initiatives into official policy frameworks.

National and EU-level funding programs, such as Horizon Europe, see reference (16), and the Digital Europe Programme, offer multi-year financial support for open digital ecosystems. These grants help establish foundational infrastructure and fund research and development activities. Additionally, institutional budget allocations ensure that Digital Commons projects receive sustained investment as part of national and municipal digital transformation strategies.

Policymakers can further enhance sustainability by implementing legal and regulatory incentives, such as tax exemptions for organizations that invest in Digital Commons development. Embedding commons-based funding mechanisms into governance structures also ensures financial stability by securing long-term commitments from public institutions.

4.4.2. Integrating Funding Strategies for Long-Term Sustainability

A single funding mechanism is insufficient to support Digital Commons in the long run. Instead, a hybrid approach is necessary to ensure financial resilience while maintaining accessibility and public interest.

A practical approach would involve utilizing direct value capture for day-to-day operational costs, such as staff salaries and infrastructure maintenance. Simultaneously, indirect value capture mechanisms can generate additional revenue from the economic benefits created by Digital Commons, ensuring that businesses and institutions that benefit contribute financially. Asset utilization strategies can then be leveraged to monetize existing digital infrastructure, while community-driven funding and institutional support ensure a broad base of financial backing.

By integrating these diverse funding strategies, Digital Commons can achieve long-term stability, financial independence, and adaptability, ensuring their continued role as a pillar of public digital infrastructure.

4.5. Conclusion

The financial sustainability of Digital Commons relies on a combination of funding sources that align with their open, community-driven nature. By structuring financial strategies around direct revenue streams, indirect value capture, asset utilization, community participation, and policy-driven support, Digital Commons can secure stable and long-term funding.

A well-balanced financial model ensures that these digital resources remain accessible, resilient, and capable of continuous innovation, ultimately fulfilling their role in promoting digital equity and public value creation.

5. CONCLUSIONS, NEXT STEPS AND APPROACH

The development of the **Digital Commons Framework (DCF)** within the 3DxVERSE project does not represent a final outcome, but rather the foundation for an ongoing process of experimentation, learning, and transformation. This deliverable has established the **conceptual, ethical, and strategic underpinnings** for reimagining how digital infrastructures can be governed and designed in the public interest. However, frameworks alone do not drive change—impact emerges through **practical implementation, iterative refinement, and collective engagement**.

To bridge the gap between principle and practice, the DCF must now be treated as a **living framework**—one that evolves dynamically through real-world application. The 3DxVERSE project offers an ideal environment in which to operationalise its core principles, including **transparency, democratic governance, inclusivity, and sustainability**. These principles will be embedded into specific project components and pilot use cases, with outcomes evaluated through structured metrics (as outlined in Chapter 3). The insights gained from this process will support iterative refinement, ensuring that both the principles and the practices remain responsive to emerging challenges and opportunities.

Recognising the **diversity of the project's use case domains**—from sustainable travel and energy to community-based living—the DCF must remain flexible and context-sensitive. These varied application areas introduce distinct challenges, and the framework must be adapted accordingly. In particular, aspects such as **governance structures** and **financial strategies** are likely to evolve significantly across contexts and will require tailored approaches.

In parallel, the **ethical use of artificial intelligence (AI)** within digital commons will be a focus area. Given the rapid pace of AI development, the DCF will need to remain responsive to its transformative potential and associated risks. While AI can significantly enhance the capabilities of digital commons, it also introduces critical ethical concerns—such as fairness, accountability, and data sovereignty—which must be addressed within the evolving framework.

A key innovation to be explored in this next phase is the **prototype implementation of a Decentralized Autonomous Organization (DAO)**, as introduced in Chapter 2.4. The DAO represents a novel model of digital governance—founded on decentralised infrastructure, participatory mechanisms, and algorithmic transparency. Within 3DxVERSE, it will serve as both a **technical and social experiment**, enabling stakeholders to collaboratively govern aspects of the digital commons. By testing the DAO under practical conditions, the project seeks to evaluate its potential to enhance **legitimacy, trust, and ethical accountability**, while also critically assessing challenges such as **decision-making efficiency, coordination, and inclusivity**.

The participatory dimension of this implementation phase will be equally vital. Ethical and effective digital governance cannot be achieved through top-down design alone; it requires **ongoing dialogue with stakeholders**, including citizens, domain experts, and public authorities. To this end, the project will facilitate **participatory workshops, feedback sessions, and scenario-based simulations** to test governance models and co-design context-sensitive adaptations of the framework.

The overarching ambition of the 3DxVERSE project is to develop a **Digital Commons Framework** that is both **theoretically robust** and **practically effective**—a framework that not only supports the current objectives of 3D but also offers a replicable model for broader application across Europe and beyond. By embedding democratic values into the design and governance of digital infrastructure, the DCF aspires to contribute to a future in which **digital ecosystems serve collective interests, promote public value, and strengthen the foundations of digital sovereignty and ethical innovation**.

REFERENCES

1. Albareda, L., & Sison, A. J. G. (2020). Commons Organizing: Embedding Common Good and Institutions for Collective Action. *Insights from Ethics and Economics. Journal Of Business Ethics*, 166(4), 727–743. <https://doi.org/10.1007/s10551-020-04580-8>
2. Artificial Intelligence Act (n.d). EU Artificial Intelligence Act | Up-to-date developments and analyses of the EU AI Act. <https://artificialintelligenceact.eu/>
3. Bühler, M. M., Calzada, I., Cane, I., Jelinek, T., Kapoor, A., Mannan, M., Mehta, S., Mookerje, V., Nübel, K., Pentland, A., Scholz, T., Siddarth, D., Tait, J., Vaitla, B., & Zhu, J. (2023). Unlocking the Power of Digital Commons: Data Cooperatives as a Pathway for Data Sovereign, Innovative and Equitable Digital Communities. *Digital*, 3(3), 146–171. <https://doi.org/10.3390/digital3030011>
4. Calzada, I. (2021). The Right to Have Digital Rights in Smart Cities. *Sustainability*, 13(20), 11438. <https://doi.org/10.3390/su132011438>
5. Combé, M., & Khutsishvili, K. (2024). Extended abstract: THE CHALLENGE OF CO-CREATION: HOW TO CONNECT TECHNOLOGIES AND COMMUNITIES IN AN ETHICAL WAY. *ETHICOMP 2024 Proceedings*.
6. Commons Network (2024). DIGITAL COMMONS Collaborative Culture. <https://www.commonsnetwork.org/wp-content/uploads/2024/07/4-Explainer-eng-.pdf>
7. De Rosnay, M. D., & Stalder, F. (2020). Digital commons. *Internet Policy Review*, 9(4). <https://doi.org/10.14763/2020.4.1530>
8. Elliott, K., & Copilah-Ali, J. (2024). Implementing corporate digital responsibility (CDR): Tackling wicked problems for the digital era: Pilot study insights. *Organizational Dynamics*, 53(2), 101040. <https://doi.org/10.1016/j.orgdyn.2024.101040>
9. Elliott, K., Price, R., Shaw, P., Spiliotopoulos, T., Ng, M., Coopamootoo, K., & Van Moorsel, A. (2021). Towards an Equitable Digital Society: Artificial Intelligence (AI) and Corporate Digital Responsibility (CDR). *Society*, 58(3), 179–188. <https://doi.org/10.1007/s12115-021-00594-8>
10. European Commission (n.d.). About the Digital Markets Act. https://digital-markets-act.ec.europa.eu/about-dma_en
11. European Commission (n.d.). Citiverse. <https://digital-strategy.ec.europa.eu/en/factpages/citiverse>
12. European Commission (n.d.). Cyber Resilience Act. <https://digital-strategy.ec.europa.eu/en/policies/cyber-resilience-act>

13. European Commission (n.d.). Data Governance Act explained. <https://digital-strategy.ec.europa.eu/en/policies/data-governance-act-explained>
14. European Commission (n.d.). The Digital Services Act. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/digital-services-act_en
15. European Council (n.d.). European declaration on digital rights and principles. <https://www.consilium.europa.eu/en/policies/european-declaration-on-digital-rights/>
16. European Commission. (n.d.). Horizon Europe https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en
17. FRA (n.d.). EU Charter of Fundamental Rights. <https://fra.europa.eu/en/eu-charter>
18. Frion, L. (2022). Digital commons as alternative systems of value. <https://www.sciencespo.fr/public/chaire-numerique/wp-content/uploads/2023/06/15-juin-DIGITAL-COMMONS-policy-brief-Louise-Frion-1.pdf>
19. Hanisch, M., Goldsby, C. M., Fabian, N. E., & Oehmichen, J. (2023). Digital governance: A conceptual framework and research agenda. *Journal Of Business Research*, 162, 113777. <https://doi.org/10.1016/j.jbusres.2023.113777>
20. Hartley, N., Kunz, W., & Tarbit, J. (2024). The corporate digital responsibility (CDR) calculus: How and why organizations reconcile digital and ethical trade-offs for growth. *Organizational Dynamics*, 53(2), 101056. <https://doi.org/10.1016/j.orgdyn.2024.101056>
21. Lobschat, L., Mueller, B., Eggers, F., Brandimarte, L., Diefenbach, S., Kroschke, M., & Wirtz, J. (2021). Corporate digital responsibility. *Journal Of Business Research*, 122, 875–888. <https://doi.org/10.1016/j.jbusres.2019.10.006>
22. Murillo, D., Guinart, P., & Arenas, D. (2024). The Ethics of Commons Organizing: A Critical Reading. *Journal Of Business Ethics*. <https://doi.org/10.1007/s10551-024-05706-y>
23. Guiding principles on business and human rights. (2011). In United Nations eBooks. <https://doi.org/10.18356/9ceabfd3-en>
24. Pappas, I. O., Mikalef, P., Dwivedi, Y. K., Jaccheri, L., & Krogstie, J. (2023). Responsible Digital Transformation for a Sustainable Society. *Information Systems Frontiers*, 25(3), 945–953. <https://doi.org/10.1007/s10796-023-10406-5>
25. Rikken, O., Janssen, M., & Kwee, Z. (2019). Governance challenges of blockchain and decentralized autonomous organizations. *Information Polity*, 24(4), 397–417. <https://doi.org/10.3233/ip-190154>

26. Toreini, E., Aitken, M., Coopamootoo, K., Elliott, K., Zelaya, C. G., & Aad, V. M. (2019). The relationship between trust in AI and trustworthy machine learning technologies. arXiv (Cornell University). <https://doi.org/10.48550/arxiv.1912.00782>
27. Trier, M., Kundisch, D., Beverungen, D., Müller, O., Schryen, G., Mirbabaie, M., & Trang, S. (2023). Digital responsibility. *Business & Information Systems Engineering*, 65(4), 463–474. <https://doi.org/10.1007/s12599-023-00822-x>
28. Trevisan, M., Traverso, S., Bassi, E., & Mellia, M. (2019). 4 Years of EU Cookie Law: Results and Lessons Learned. *Proceedings On Privacy Enhancing Technologies*, 2019(2), 126–145. <https://doi.org/10.2478/popets-2019-0023>
29. United Nations. (n.d.). Universal Declaration of Human Rights | United Nations. <https://www.un.org/en/about-us/universal-declaration-of-human-rights>
30. United nations. (n.d.). The Sustainable Development Agenda. <https://www.un.org/sustainabledevelopment/development-agenda/>
31. Van Vulpen, P., & Jansen, S. (2023). Decentralized autonomous organization design for the commons and the common good. *Frontiers in Blockchain*, 6. <https://doi.org/10.3389/fbloc.2023.1287249>
32. Wolford, B. (2024, 29 augustus). What is GDPR, the EU's new data protection law? GDPR.eu. <https://gdpr.eu/what-is-gdpr/>
33. European Commission (n.d.). Industry 5.0. https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/industry-50_en
34. Access Now (2024). Access Now's vision for an EU digital rights agenda. <https://www.accessnow.org/publication/our-vision-for-an-eu-digital-rights-agenda/>
35. World Economic Forum (2023) Tech for good: What it means and how we can deliver on it. <https://www.weforum.org/stories/2023/03/tech-for-good-what-does-it-mean-and-how-can-we-deliver-on-it/>
36. European Commission (n.d.). Ethics By Design and Ethics of Use Approaches for Artificial Intelligence. https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ethics-by-design-and-ethics-of-use-approaches-for-artificial-intelligence_he_en.pdf
37. LGT Group (2024). Tackling the sustainability challenge collectively. <https://www.lgt.com/global-en/market-assessments/insights/financial-knowledge/tackling-the-sustainability-challenge-collectively-247494>