Towards a sustainable Open Data ECOsystem

D2.3
User needs from a governance perspective

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Abbreviations

D	Deliverable
ESR	Early Stage Researcher
ESRI	Environmental Systems Research Institute, Inc
EU	European Union
M	Milestone
NGO	Non-government organisation
NPO	Non-profit organization
OD	Open Data
ODG	Open Government Data
ODECO	Open Data ECOsystem
OD Ecosystems	Open data ecosystems
OSM	Open Street Maps
SESR	Supervisor of an Early Stage Researcher
VGI	Volunteered Geographical Information
WP	Work Package

Nr	Partner	Partner short name	Country
Beneficiary			
1	Technische Universiteit Delft	TU Delft	Netherlands
2	Katholieke Universiteit Leuven	KUL	Belgium
3	Centre National de la Recherche Scientifique	CNRS	France
4	Universidad de Zaragoza	UNIZAR	Spain
5	Panepistimio Aigaiou	UAEGEAN	Greece
6	Aalborg Universitet	AAU	Denmark
7	Università degli Studi di Camerino	UNICAM	Italy
8	Farosnet S.A.	FAROSNET S.A.	Greece
Partner organisations			
1	7eData	7EDATA	Spain
2	Digitaal Vlaanderen	DV	Belgium
3	City of Copenhagen	COP	Denmark
4	City of Rotterdam	RDAM	Netherlands
5	CoC Playful Minds	CoC	Denmark
6	Derilinx	DERI	Ireland
7	Esri	ESRI	Netherlands
8	Maggioli S.p.A	MAG	Italy
9	National Centre of Geographic Information	CNIG	Spain
10	Open Knowledge Belgium	OKB	Belgium
11	SWECO	SWECO	Netherlands
12	The government lab	GLAB	United States of America
13	Agency for Data Supply and Infrastructure	ADSI	Denmark

1 Introduction

The aim of this report is to outline the first steps towards the creation of a governance model to involve producers and users in Open Data Ecosystems (ODE) in a sustainable manner. In this report, we explore how to sustainably involve producers and users in the open data ecosystem by developing and evaluating an open data ecosystem (ODE) governance model driven by commons-based governance principles.

This governance model was developed in three stages. The first stage consisted of exploring several governance models for engaging different users' groups in a sustainable manner, through a comprehensive literature review and desk research. Based on our interpretation of this literature, in the second stage we emphasize how commons-based governance strategies for data commons are suitable for ensuring sustainability of open data ecosystems. In the third stage we gathered empirical evidence on the existing governance and legal strategies, by synthesizing individual research projects focused on specific user groups, such as non-specialist data users (covered by ERS1), local government (ESR 6), journalist (ESR9), students (ESR10), NGOs (ESR11), regional/central government (ESR12), companies (ESR13) and data intermediaries (ESR15). This empirical data collection was conducted as the first of two rounds of a Delphi-based methodology. The data collection was framed from the perspective of obtaining data regarding practices of communing in various open data ecosystems (ODEs), which further solidified the commons-based principles proposed in this report.

The governance model was evaluated with the user groups previously mentioned as part of the second round of the Delphi methodology applied by circulating it among the ODECO consortium to obtain feedback in the form of a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis.

This report, which contributes the development and testing of the governance model, proceeds as follows:

- In Section 2, we provide a conceptual framework that contributes an overview of the concept of data ecosystems, governance, and data governance, and elaborate on the need for a new approach to governance of OD Ecosystems.
- In Section 3 we provide a conceptual overview of the application of commons-based governance principles to OD Ecosystems. We also establish a link between Section 2, where we articulate the need for new governance approaches for OD Ecosystems. This is linked to the need to rethink value in OD Ecosystems, as encompassing both economic value and social value, which establishes the link to commons-based governance.
- In Section 4, we present the methodology of this report and briefly summarize the empirical findings on existing practices of collaboration, collective decision-making, monitoring, and other aspects of commons-based governance that are present in different OD Ecosystems.
- In Section 5, we present the commons-based governance model for open data ecosystem and its evaluation. The feedback received is also presented in this section, which will serve as one of the sources for iteration of this governance model in subsequent deliverables.
- In Section 6, we synthesize a conclusion.

2 Conceptual framework

This section provides an overview of two foundational concepts for this report: open data ecosystems, and governance. In this section, we will elaborate on the need for appropriate and effective governance models for OD Ecosystems.

2.1 Theoretical background on 'open data ecosystems'

In this sub-section we present several theoretical constructs shaping our understanding of *open data ecosystems*, beginning with how the concept of *ecosystem* has been initially defined in natural sciences and continuing with the other domains which incorporated the concept, including business and technology. We will then connect these concepts and present a working definition for this deliverable, which could be strengthened and relied on in future deliverables.

2.1.1 Ecosystem in natural sciences

The term "ecosystem" was introduced by Tansley in 1935 to describe the fundamental components of nature, integrating biological, physical, and chemical elements. Initially, it referred to a system comprising organisms and their influencing physical factors (Golley, 1993). Ecosystem studies progressed with Lindeman (1942) and were used to unify field data by Odum and Barrett (1971). In 2012, Likens and Bormann conducted a pivotal systemic analysis of ecosystems, highlighting their functioning, components, and responses to external factors. Today, the most common definition of an ecosystem is "a dynamic complex of plant, animal, and microorganism communities and their non-living environment, interacting as a functional unit" (Convention on Biological Diversity, 2006).

Tansley (1935) first problematized the term "ecosystem" by highlighting its holistic nature, focusing on interactions within and between components (organisms) as well as their relationship with the entire system—both organic and inorganic. This posed a conflict between the scientific need to isolate components for study and the concept's inherent interconnectedness, as Tansley acknowledged: "The systems we isolate mentally are not only included as parts of larger ones, but they also overlap, interlock, and interact. The isolation is partly artificial but necessary".

Yet, some researchers like Yeo (1986) challenged this holistic approach, criticizing its artificial generalizations that combined physics and natural elements. Tansley introduced key aspects for studying ecosystems: variety, autonomy, integration, organization, equilibrium, stability, and climax. These aspects, while not fully defined at the time, offer valuable insights for understanding success criteria in ecosystems. However, they have faced challenges from scientists like Simberloff and colleagues (Simberloff & Dayan, 1991) and Patten and Odum (1981), who argue that ecosystems are not inherently goal-oriented and self-regulating.

The ecosystem concept also serves as a bridge between science and society, particularly in the context of studying Data Ecosystems from a social sciences perspective (Golley, 1993). To explore this further and propose a working definition for this report, we will analyse interpretations and uses of the ecosystem metaphor across various domains, including data studies.

2.1.2 The ecosystems concept adopted by the business domain

J.F. Moore has proposed a well-established adaptation of the ecosystem metaphor in the business domain (Moore, 1993, 1996; Moore, 2006). In his definition, a business ecosystem is not defined by what it is, but by what it does. Similar to a natural ecosystem, a business ecosystem evolves from randomness to structured communities, progressing through stages of birth, expansion, leadership, and potential decline. What remains consistent is the co-evolution, the interplay between competitive and cooperative strategies (Moore, 1993, p. 76). Moore compares a business

ecosystem to a natural ecosystem, emphasizing the community aspect supported by interacting components. He also details the capabilities and roles of business ecosystem components, highlighting the importance of leadership to establish a shared vision. More recently, Moore introduced the concept of openness within business ecosystems, where additional, non-traditional members can contribute alternative ideas. He describes a business ecosystem as a network of interdependent niches occupied by organizations, with varying degrees of openness to embrace alternative contributors (Moore, 2006, p. 34).

In the business domain, Moore's work has evolved over time. Kelly (2015) introduced a definition emphasizing the coexistence of cooperation and competition, highlighting the importance of value creation and capture within the ecosystem: "dynamic and co-evolving communities of diverse actors who create and capture new value through both collaboration and competition" (Kelly, 2015, p. 4). Value is generated through interactions and by benefiting from the ecosystem's intrinsic value, which goes beyond the cumulative value of all interactions (Borgh et al., 2012). Moreover, value is created by actors, which, drawing from systems-thinking theory, interact based on their abilities to organize and share resources within the environment (Caputo et al., 2018). This holistic understanding aligns with the natural science definition. Actors may assume various roles, influencing their cooperative and competitive interactions with others having different or overlapping roles (Ikävalko et al., 2018).

Beyond interactions and components, researchers examine conditions affecting ecosystem success. Stam (2015) distinguishes socio-cultural and infrastructure conditions, encompassing knowledge, talent, and leadership. Dessers and Mohr (2019) compare networks and ecosystems, noting distinctions in purpose, composition, integration, and governance. Ecosystems have a more loosely shared purpose, lack formal membership and governance, and involve both competition and collaboration. In contrast, networks emphasize collaboration and dependence.

2.1.3 (Open) Data Ecosystems

In the datafied society, the ecosystem metaphor characterizes the "data environment supported by a community of interacting organizations and individuals" (Cavanillas et al., 2016, p. 33). This conceptualization is emerging from prior work in business ecosystems and is rapidly adopted across various domains engaged in digital transformation. These domains include health, care services, mobility, big data, ecosystem services, IT services, financial services, public services, spatial planning, government, logistics, media, manufacturing, and pharmaceuticals.

These domains share a focus on the impact of data on society within the context of digital transformation in the public and private sectors. The European Union, as well as other geopolitical forces like China and the USA, are rapidly expanding and regulating data-driven and AI-focused development. The Europe Union formulated a data strategy to create a common and accessible market for data, combining public sector datasets and personal data spaces, with a focus on data governance and access (European Commission 2018, European Commission 2020). These political and regulatory developments are of interest to the scientific community, including digital ecosystem and software ecosystem researchers. The digital ecosystem represents an evolution from business ecosystems, emphasizing the use of technology to advance cooperation and value creation. Actors from various domains collaborate by exchanging data to optimize services.

The software ecosystem describes interactions aimed at developing, commercializing, and using software technologies and services. The data ecosystem characterizes a dynamic socio-technical system where individuals, businesses, and organizations as well as governments cooperate and compete to co-create value within a technology-driven data environment. This concept is explored

by various researchers (Cavanillas et al., 2016; Demchenko et al., 2014; Geisler et al., 2022; Oliveira & Lóscio, 2018; Van Loenen et al., 2021).

In their taxonomy of data ecosystems, Gelhaar et al. (2021) considered Openness and Interdependence as key dimensions of data ecosystems, besides other dimensions such as Domain, Purpose, Organization, Infrastructure and Control. With regards to the Interdependence dimensions, tightly coupled data ecosystems could be distinguished from more loosely coupled ecosystems, while data ecosystems can be open or more closed.

2.1.4 Open data ecosystems

Data ecosystems typically emerged within a specific sector or industry (e.g. healthcare, financial sector, mobility, etc.) or at a specific geographical scale (e.g. local/city data ecosystems, national data ecosystems, etc.). Open data ecosystems, in which organizations share and (re-)use open data, can be considered as a particular type of data ecosystems, which received considerable attention in the open data community.

In 2011, Pollock (2011) introduced the concept of the "(open) data ecosystem", advocating for a transformation of traditional OD systems where data flows in a linear fashion from providers to users. The proposed OD Ecosystem represent a paradigm shift, envisioning data as a dynamic and continuous cycle among various actors, with intermediaries playing a crucial role. These intermediaries bridge the gap between data providers and users, adding substantial value to the data ecosystem. OD Ecosystems are expected to foster collaborative efforts for creating value from data and provide reusable components, thereby challenging conventional data management approaches.

Pollock's pioneering work paved the way for subsequent approaches, often emphasizing Open Government Data (OGD) contexts. Scholars such as Ubaldi (2013), Dawes et al. (2016), and Harrison et al. (2012) further explored OGD ecosystems, addressing technical optimizations, active networks for information sharing, and the varied scales at which these ecosystems can operate, from the organizational level to worldwide domains. Kapoor et al. (2015) highlighted the multifaceted activities within OD Ecosystems, while Mulder (2015) extended the framework to encompass the actors and the political and organizational structures that support or participate in these activities.

An underlying theme in OD Ecosystems is the interdependence among stakeholders, underscoring a shared responsibility for the ecosystem's success or failure. The ecosystem metaphor reinforces the idea that users, technology innovators, government leaders, data managers, and policymakers are interdependent in efficiently developing OD Ecosystems to generate value for all participants (Harrison et al., 2012).

2.2 What is governance and why do we need governance for open data initiatives?

In this sub-section we introduce and briefly explain different views on governance, starting with a broader definition of governance and afterwards focusing on governance in the context of data and data initiatives.

2.2.1 Introducing governance

The concept of "governance" is used in several contexts such as corporate governance, international governance, national governance, local governance. In essence, governance deals with the process of decision-making and the process by which decisions are (or not) implemented. Governance encompasses the system by which entities are directed and controlled and the mechanisms by which it, and its people, are held to account. It is concerned with structure and processes for decision-making, accountability, control and behaviour at the top of an entity.

Governance influences how the objectives of an organization or network are set and achieved, how risk is monitored and addressed and how performance is optimized.

Governance is not a single activity, but a larger system and process, which according to the Institute on Governance (2024), should provide answers to key questions such as: *How are decisions made? Who has a voice in making these decisions? Who has the authority to act on behalf of the organisation or network? Who is accountable for how an organisation/network and its members behave and perform?*

To illustrate the use of the governance concept in different contexts (and with different meanings), Rhodes (1997) distinguishes six uses of the term governance in his book 'Understanding Governance'.

- Governance as the minimal state: the use of markets and quasimarkets to deliver 'public 'services'.
- Governance as corporate governance: this is mainly about transparency, integrity and accountability, by means of control.
- Governance as the new public management: the introduction of private sector management methods and incentive structures such as market competition to the public sector.
- Governance as 'good 'governance': a 'marriage of the new public management with liberal 'democracy'.
- Governance as a socio-cybernetic system: interdependence among social-political-administrative actors; governance is the result of interactive social-political forms of governing.
- Governance as self-organising networks: networks develop their own policies and shape their environments.

Provan and Kenis (2008) especially emphasize the distinction between organizational governance and network governance. Organizational governance is strongly focused on the role of boards of directors in representing and protecting the interest of stakeholders. Network governance focuses on interactions and cooperation between - networks - of autonomous organizations, which aim to work together to achieve not only their own goals but also a collective goal. Organizations can form such networks for a variety of reasons, including the need to gain legitimacy, serve clients more effectively, attract more resources, and address complex problems. Regardless of the specific reason, network organizations are seeking to achieve some end that they could not have achieved independently. While it can be argued that data ecosystems are about the governance of networks – of actors and organizations, they can rely on different governance mechanisms.

2.2.2 Governance of open data initiatives

Public administration and open data scholars have especially looked into the governance of public or open data initiatives. Such initiatives traditionally involve and affect various stakeholders from different sectors and domains, including public authorities, decision makers, businesses, citizens, researchers, non-profit organizations and many others.

The effective development and implementation of these initiatives requires governance, which includes the structures, policies, actors and institutions by which the – open - data initiatives are managed through decisions on producing, accessing, sharing, exchanging and using different types of data (Vancauwenberghe & Crompvoets, 2018). A lack of ineffective governance of open data will lead to typical governance problems, such as gaps, duplications, contradictions and missed opportunities. Examples of these problems in the open data domain are missing datasets that are interesting to many users, non-functioning open data portals, the adoption of different and sometimes contradictory standards or licenses, inconsistent regulations, a lack of sustainable financial management, and potential open data use cases that could not be implemented because

of missing or inadequate data. The key challenge of governance is reconciling collective and individual needs and interests of different stakeholders in order to achieve common goals.

In their study on governance practices in the context of open data initiatives, Vancauwenberghe and Crompvoets (2018) identified six sets of governance instruments that are used for governing open data initiatives: collective decision-making structures, strategic management, allocation of tasks and responsibilities, creation of markets, interorganizational culture and knowledge management, and regulation and formalization of open data initiatives.

Following the public governance literature and logic, these instruments can be linked to three main governance models (Chantillon et al. 2017):

- Hierarchy-based governance: This type of governance is based on the idea that authority and power are the fundamental processes and resources. There can be bureaucratic hierarchical control, e.g. through rules, internal authority and political control. This type of governance works via a broad range of possible tools, ranging from legislation to procedural control mechanisms.
- Market-based governance: Using the markets as a governance mechanism is based on the idea that bargaining is the basic process and resource. In markets buyers and sellers come together and bargain until they find a common agreement—in this way a balance is found between supply and demand.
- Network-type mechanism: Networks are considered to be '(more or less) stable patterns of cooperative interaction between mutually dependent actors around specific issues of policy (or management). So, between organisations there is cooperation based on voluntary collaborative actions as well as solidarity between organisations. There is bargaining, negotiation and co-operation between the participating organisations, based on trust, a certain level of information-sharing and time.

Generally speaking, the creation of markets can be considered as a way of market-based governance, while a strong regulation and formalization of open data initiatives relates to more hierarchy-based governance. Collective decision-making (structured) and the creation of an interorganizational culture and knowledge management rather are network-based governance instruments. It should be noticed that most of the governance instruments identified by Vancauwenberghe and Crompvoets (2018) can be used in different ways, and not always can be strictly associated to one of these three models.

2.2.3 Data ecosystems governance

Data ecosystems serve as platforms for understanding the intricate interplay between data, its technical constituents, and the socio-cultural elements that frame data, engendering value for actors and society at large (Kitchin, 2014).

In this context, data governance becomes increasingly pertinent, encompassing stakeholder decisions that shape how data generates value within the ecosystem. Within this research context, governance signifies the outcome of governing, involving social interactions, negotiations, and collaboration among actors engaged in a data initiative (Colebatch, 2014).

In their exploration of emerging data governance models, Micheli and colleagues (2020, p. 3) define data governance as *"the power dynamics among all actors affected by or influencing data's accessibility, control, sharing, and use, the intricate socio-technical arrangements for extracting value from data, and the equitable redistribution of such value"* Their research aligns with the discourse advocating innovative data governance models that promote horizontal collaboration and democratic principles, countering the prevailing model focused on the monopolistic gains of major tech entities (van Dijck et al., 2018; Kitchin & Lauriault, 2014; van Dijck, 2014).

According to Micheli et al. (2020) the dominant 'data governance model' is "the one established by a few corporate big tech platforms collecting and economically exploiting massive amounts of personal data". Starting from the observation that "other actors beyond 'big tech' is progressively becoming involved in controlling personal data and producing value from it through different data governance models", Micheli et al. (2020) contrast this model with four models emerging from the practices of these other actors: data sharing pools, data cooperatives, public data trusts, and personal data sovereignty.

In the taxonomy for data ecosystems of Gelhaar et. al (2021), there are two key dimensions related to the governance of data ecosystems: interdependence and control. Interdependence relates to the difference between tightly and loosely coupled actors. Control refers to the control of the essential data resources in the data ecosystem. The - key - data resources can be controlled by a central actor, e.g. a keystone actor, or can be decentralized and therefore spread across the multiple actors in the data ecosystem. When focusing on open data (ecosystems), the 'control' dimension of governance will be different, as it will be more difficult – or even impossible – for actors to exercise control over the access to and (re)use of data.

2.3 Conclusion – in need for a new perspective on governance

Summarizing the existing literature on the governance of – open – data ecosystems, the following points should be considered when designing effective governance models. There is some agreement among scholars and practitioners that – open – data ecosystems demand for new governance models. An alternative is needed for the dominant – market-based - model of the "big tech platforms" but also network-based governance models seem to fail – or have their limitations for the governance of open data ecosystems. While the governance of open data ecosystems in essence is about governing networks of actors, there are important differences between networks and ecosystems. In networks, collaboration and dependence are central. Ecosystems often lack formal membership and governance, and usually rely on both competition and collaboration. As Dessers and Mohr (2019, 2022) argue, ecosystems involve the co-creation of purpose and values – as aspect that is central to commons as well, as explored in Section 3 below.

To illustrate the complexity of open data ecosystems governance, Micheli et al. (2020) identify different analytical dimensions in which possible governance models can vary: the key actors, the governance goals, the value from data, the governance mechanisms and the power relation between these actors. This adds another level of complexity to the understanding of possible governance models. Beyond understanding which models exist and what these models entail, there's also the question on their effectiveness and impact, which is central in the design of effective governance models. In the next sections we will also look into this, by critically looking into the value of open data ecosystems.

3 A commons-based approach to governance

In this section, we introduce a commons-based approach as one possible approach to governance of OD Ecosystems. In sub-section 3.1, we articulate the need to think broadly and critically about value and outline certain rationales for the use of commons-based governance principles to co-create and co-produce value. In sub-section 3.2, we propose initial ideas for extending commons-based governance principles in the context of the OD Ecosystems.

3.1 The link between value and the commons

3.1.1 Rethinking value from a broader perspective: adding co-production and co-creation of value

The capitalist interpretation of value as criteria for entrepreneurial success and measure for company profit, serving (mostly) private benefits is being addressed to a greater extent by critics for the lack of vision and beneficial impact for society (Auerswald, 2009), for driving exploitation and injustice (Walker, 2017) and depleting planet resources and accelerating the climate crisis (Muniesa, 2017). Meanwhile, public value as the measure for societal goals translated into visions for public policy and the creation of public goods and services leaves many gaps in terms of social justice and equal access to resources in society (DiMaggio & Anheier, 1990) which can also be seen as opportunities to innovate (Austin et al., 2006).

The emerging field of social innovation studies the creation of social value through innovative means by social entrepreneurs, organizations, communities and the institutions, strategy and policies which facilitate social value creation (van der Have & Rubalcaba, 2016). In this context, new types of social entrepreneurship that address societal problems emerge in various innovative environments from private companies to NGOs and partnerships between public and private organizations (Austin et al., 2006; Dohrmann et al., 2015). These environments where innovative transformation takes place contribute to the creation of value, defined by scholars as a collaborative process where stakeholders are actively providing input for innovative services, products of value for society (Ansell & Torfing, 2021; Brandsen et al., 2018).

As such, this creation process is embedded in social systems consisting of interactions, roles, social positions, rules and norms (Edvardsson et al., 2011) and is closely linked to the context where their interactions take place (Vargo, 2008). Moreover, it involves the interaction of networks of stakeholders belonging to "constellations" (Ramaswamy & Ozcan, 2018) or interactions between companies and customers (Grönroos, 2011) or between citizens and public authorities (Haug & Mergel, 2021; Panagiotopoulos et al., 2019).

As such, defined from a commercial business and marketing perspectives, co-creation represents an "authentic dialogue between firms and consumers" (Ansell & Torfing, 2021, p. 34). Moreover, co-creation is seen as a shift from a goods dominant logic of value-in-exchange created when a product is sold to the customer, to a service dominant logic of value-in-use being continually co-created with the customer (Vargo et al., 2008) whose experience gains central place (Osborne & Strokosch, 2013). This shift has been previously announced by researchers in the public sector domain, where the idea of co-production was first introduced by Elinor Ostrom and colleagues in the context of government services created with active input from citizens (Ostrom, 1978). Similar to value co-creation, co-production refers to the collaboration between citizens and public authorities to create, design and implement public services (Brandsen et al., 2018).

This idea of interaction between the public, public institutions and private organizations with the goal of creating innovative services that bring societal value puts emphasis on the diverse nature of this value which can be user and group value as well as environmental and social value (Bovaird

& Loeffler, 2012). On this account scholars have been emphasizing the joint efforts that need to take place in order to create such multi-layered value and compare co-production and co-creation with collaborative governance, a type of governance where all stakeholders are contributing from an equal perspective to their shared common goal (Ansell & Torfing, 2021).

Finally, as value is being addressed by literature in marketing, business, but also public administration and social innovation as part of a continuum of (social) forces that create it, shape it and distribute it. As such, it is implied that value flows from one stakeholder to another, all part of a wider system and is in a constant state of exchange and distribution (Edvardsson et al., 2011; Vargo, 2009).

3.1.2. Rethinking the value of open data

Numerous studies have contextualised the concept of 'value' as it relates to open data. For instance, some studies focus on the economic value of open data. One empirical study focuses on how open data can reduce the cost of provision of public services by governments, help improve the quality of existing services, and enable the creation of new services at lower costs (Gruen et al., 2014). Other empirical studies focus on the economic value of open data for private companies, including small and medium enterprises (Scott, 2014; Verhulst and Caplan, 2015). But apart from solely focusing on economic value of open data, some studies also focus on social value of open data. For example, López Reyes and Magnussen (2022) identify four strands along which literature on the use of open government data by citizens and the creation of social value can be organised – governance, availability, adoption and impact. Other empirical studies outline variegated examples of the 'value' of open data, which spans economic value, social value and public value (OKFN 2012, Keseru and Chan, 2015).

However, a range of policy and regulatory instruments issued by the European Commission call attention to only economic aspects of open data based on- (I) the characterization of open data as an economic good or resource, and (ii) its role as a factor of production in boosting innovation in the digital economy (European Commission, 2014; European Commission, 2017; European Commission 2020; Data Governance Act, 2022; Data Act, 2023). Global diffusion of these perspectives is evident from policy initiatives of international developmental organisations (World Bank, 2016; OECD, 2019). Existing European regulatory instruments dealing with open data, in particular the EU Directive on open data and the re-use of public sector information (hereinafter 'PSI Directive') and the newly implemented EU Regulations on European data governance (the Data Governance Act is hereinafter 'DGA'), introduce legal provisions for re-use (and in some cases, access) of multiple categories of data.

A range of open data initiatives also focus on other 'social' aspects concerning open data, such as questions of data literacy, equitable data access, and non-commercial / fair re-use of open data. For example, the DGA allows individuals to donate data in the public interest, thereby introducing a new modality by which citizen-contributed data as well as data donations by non-government data producers can enter OD Ecosystems.

As Purtova and van Maanen (2023, p. 4) argue that "*[adopting] data as an economic good as a focus of the governance efforts is hardwired to only produce governance strategies that will facilitate the provision of more or better-quality data. This is in line with a broader criticism of the performativity of economic analyses, which do not merely study but also shape the world as an economy. If the regulatory objective is to attain other societal goals beyond data provision, e.g. to protect privacy and other fundamental rights and interests relating to data, empower individuals, or even strengthen the digital economy, the focus on data as an economic good is not productive".*

We extend this argument to open data initiatives. The objectives of open data initiatives are to attain various goals such as promoting economic and social value creation, improving efficiency and effectiveness of public services, increasing transparency, increasing accountability of institutions, and increasing citizen participation. To attain these goals, the regulatory/governance focus cannot simply be on technical or economic aspects of open data. Equal regulatory and governance focus is also required on other aspects where open data serves an instrumental role – such as the creation of communities, the development of open data skills, and sustainability of the OD Ecosystem.

In this regard, we infuse a broad understanding of value into our proposals for governance frameworks for OD Ecosystems. Assessing the value *of* open data purely in its exchange value – as either a resource for innovation, competition or European digital sovereignty – is limiting, as it ignores the co-creation and co-production of value *through* open data. We seek to develop governance frameworks for OD Ecosystems that critically account for both the economic value of open data *as well as* social values co-created and co-produced *through* open data.

3.1.2 Learning from commons-based governance principles for value co-creation and co-production

One theory/framework for governance that has focused on co-creation and co-production of value is the commons-based governance framework.

The theory on governance of the commons arose out of Elinor Ostrom's research, which resulted in the publication of her book 'Governing the Commons' published in 1990. Drawing from empirical research on different types of local commons, Ostrom theorized a 'third way' of governance of shared natural resources in order to ensure sustainability. This 'third way' of governance is community-driven and is an alternative to state-led and market-determined forms of resource-governance (Ostrom, 1990). Ostrom based her theorisations on many empirical case studies where shared natural resources were managed and distributed in innovative ways by communities – case studies that stood in stark contrast to the thesis of the tragedy of the commons.

Ostrom defines a 'common property resource' as a natural or manufactured resource system that is subtractable, but where it is difficult to exclude potential beneficiaries (Ostrom 1990, p. 30) Through this definition, Ostrom sought to introduce a new type of good that is different from private goods, public goods and club goods.

		Subtractability of use	
		High	*Low*
Difficulty of excluding beneficiaries	*High*	Common-pool resources	Public goods
	Low	Private goods	Club (toll) goods

Figure 1: Four types of goods[1]

Ostrom then distinguished between two facets of a common-property resource – the stock variable and the flow units.

[1] Elinor Ostrom, 'Beyond Markets and States: Polycentric Governance of Complex Economic Systems', American Economic Review vol.100, 2010, p 645.

- "*Resource systems are stock variables that are capable under favourable conditions, of producing a maximum quantity of a flow variable without harming the stock or the resource system itself"* (Ostrom 1990, p. 30).
- *"Resource units are what individuals appropriate or use from resource systems"* (Ostrom 1990, p. 30).

Based on these definitions, a fishing basin would be a resource system, while the specific quantities of fish harvested from this basin would constitute the resource units.

Ostrom then defines two central 'dilemmas' of common property resources. The first is the appropriation dilemma, which relates to appropriation of resource units from a resource system (Ostrom 1990, p. 30). The question of access to or allocation of benefits of a resource system typifies the appropriation problem and has been historically studied through the lens of enclosure. In the context of natural common property resources like fishing grounds, the appropriation problem is highlighted by the existence of commercial fishing companies who over-appropriate the resource units, i.e. the fish or who otherwise control access to the resource units. The second dilemma is the provision dilemma, which relates to provision of the resource system itself and as a result, to sustainability of the resource system (Ostrom 1990, p. 31). In the traditional commons, badly managed provision leads to depletion of the resource system itself.

Design principles derived from studies of long-enduring institutions for governing sustainable resources:

1. *Clearly defined boundaries*. The boundaries of the resource system (e.g., irrigation system or fishery) and the individuals or households with rights to harvest resource units are clearly defined.
2. *Proportional equivalence between benefits and costs*. Rules specifying the amount of resource products that a user is allocated are related to local conditions and to rules requiring labor, materials, and/or money inputs.
3. *Collective-choice arrangements*. Many of the individuals affected by harvesting and protection rules are included in the group who can modify these rules.
4. *Monitoring*. Monitors, who actively audit biophysical conditions and user behavior, are at least partially accountable to the users and/or are the users themselves.
5. *Graduated sanctions*. Users who violate rules-in-use are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other users, from officials accountable to these users, or from both.
6. *Conflict-resolution mechanisms*. Users and their officials have rapid access to low-cost, local arenas to resolve conflict among users or between users and officials.
7. *Minimal recognition of rights to organize*. The rights of users to devise their own institutions are not challenged by external governmental authorities, and users have long-term tenure rights to the resource.

For resources that are parts of larger systems:

8. *Nestled enterprises*. Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises (based on E. Ostrom 1990, 90).

Figure 2: Ostrom's design principles for long-term self-governing commons[2]

Finally, Ostrom presents her empirical research on various common-property resource systems around the world. These case-studies highlight the ways in which communities have self-managed

[2] ELINOR OSTROM, UNDERSTANDING INSTITUTIONAL DIVERSITY (2005), 258.

the appropriation and provision dilemmas for their respective common-property resources. From these case-studies, Ostrom outlined a set of design principles for governance of the commons as a tool to institutionalise commons-based governance. She identified the following eight design principles (hereafter referred to as 'commons-based governance principles') for sustainable resource management (see also Cox et al., 2010).

Ostrom (together with her colleagues) generalised her commons-based governance principles (by tracing their genesis to foundational principles of evolutionary biology) to make them "relevant to nearly any situation where people must cooperate and coordinate to achieve shared goals" (Wilson et al., 2013). As an illustration, Ostrom and her colleagues apply the principles to the study of educational groups and urban neighbourhoods (Id). In this regard, Alford (2013) notes that because of their adoption of polycentricity (for e.g., in recognising nested enterprises) and their flexibility in implementation, the commons-based governance principles can offer rich insights for the study and implementation of co-production (Alford, 2013). In fact, the principles have since been extended, to be used "as a heuristic to support planning, delivery, and evaluation [that can] support the co-creation of value by groups encompassing public contributors/service users and multiple service providers within and/or across systems" (Williams et al., 2023).

Pazatis et al. (2021, pp 258) go one step further, to articulate a theory of value as a commons: "*Value is an expression of a collective agreement, and action upon it, on what is important. It functions insofar people uphold the shared norms and rules that make the system work. Value as a commons defines the meaning of actions, processes, and relations amongst them as inherently collective and embedded in certain social and ecological conditions. Value as a commons is manifested in people's capacities to arrange their life affairs and co-produce their livelihoods through sharing and participation in common doing. Value is created when these capacities are improved, and it is destroyed when they diminish"* (See also Bollier, 2016). In this regard, digital commoners have proposed alternate value capture and assessment frameworks, such as the 'Open Value Network' where participants of a commons create common value but keep account of different individual contributions in a common ledger, creation of open value accounting principles, and the concept of ''transvestment' to allow commons-based projects to accept capital but subject it or "discipline it" in accordance with commons-based anti-capitalist principles (Bauwens and Niaros, 2017; Bollier, 2016, pp 38-42).

3.2. Extending commons-based governance principles to OD Ecosystems

In Sections 2.1.4 and 2.1.5, we presented the concept of OD Ecosystems as socio-technical infrastructures that comprise of complex, non-linear interrelations and interdependencies between various technical, social and organisational 'actants' for the generation, use and re-use of open data. In Section 2.2, we articulate the need for governance frameworks that account for this 'ecosystemic' approach to open data. In Section 3.1 above, we also articulate the need for such governance frameworks to be oriented towards economic value creation (by creating, as mentioned above, an authentic dialogue between firms and consumers) as well as social value co-creation and co-production, for which we can draw inspiration from commons-based governance principles.

In this section, we expand on how commons-based governance principles can be applied to OD Ecosystems. In this regard, we note that commons-based governance principles have been extended to open government data (Raymond and Kouper 2023) as also to OD Ecosystems more generally (Linåker and Runeson, 2022).

3.1.3 Pure open data v. openness along a continuum

At the outset, we recognise that the 'definition'' of open data has been institutionalised to a great extent by the Open Data Charter, which defines open data as "digital data that is made available

with the technical and legal characteristics necessary for it to be freely used, reused, and redistributed by anyone, anytime, anywhere" (ODC, 2015). The Open Knowledge Foundation provides an expanded version of this definition of open data as data (and content) that "anyone can freely access, use, modify, and share for any purpose (subject, at most, to requirements that preserve provenance and openness)" (OKFN, 2015).

Focusing on the politics and practice of open data, in addition to its techno-legal essence
More generally on 'open', the Open Knowledge Foundation acknowledges that the current definition of 'open' does not engage with new discourses on the impact of "*data extractivism, digital colonialism, economic, racial and gender-based violence and inequalities, and the effects of an open ecosystem on climate justice*" (OKFN, 2023). As critical data studies researchers note, there is a need to study open data not just in terms of technical or economic 'openness', but also the politics of data, i.e. the praxes and choices underpinning the generation, use and re-use of data (including open data) (Kitchin 2014, Jerome and Goeta 2015). Purely technical or economic approaches to open data focus largely on enabling access and re-use of data that is 'out there' , and don't focus enough on questions of who made decisions about what becomes data, who decides how open data is presented, who decides how open data can be used and is used, and whose interests are represented/ignored in open data gathering and data use/re-use (Gurstein, 2011; Kitchin, 2014; Kitchin 2021).

Critical scholarship also focusses on the "praxes, choices and politics" of data (including open data) (Kitchin. 2021, pp. 30). One slice of this scholarship focusses on the politics and practices by which open data comes into existence and is sustained (Courmont, 2012; Meijer et al., 2014; Denis and Goeta, 2017; Courmont, 2017; van Maanen, 2023). Another slice addresses the issue of who/what is represented in/by open data, and who/what is missed out as part of data quality (Feng and Shah, 2022; Fernández-Ardèvol and Rosales, 2022). A third slice addresses the issues of effective use (and harmful re-use) of open data (Gurstein, 2011).

In a related fashion, legal proponents of the open movement also draw attention to the double-edged nature of 'open'. While increasing availability and findability of open data is necessary to ensure transparency and accountability as well as boost efficiency of market players in a digital economy, this access-driven focus on open data does not account for platform-driven structures of power (Open Future, 2021). A range of open data intermediaries have come into existence who, instead of optimizing open data, appropriate existing open data to create proprietary innovations without contributing to OD Ecosystems (Id.) Further, a large amount of data, information, content and knowledge is being created on/through platforms that exercise infrastructural control over this data across the hardware, software, application and protocol layers (Id.) Equally, a large amount of data that is sought to be made open data (such as mobility data) is being generated on 'miniaturised technologies' such as sensors and wearables which presents a rich source of data but whose access and re-use fraught with ethical and privacy concerns that cannot be ignored (Morelli et al., 2017, pp. 2).

As a result, as Kapoor et al. (2015, pp 3) note "In order to accelerate the collective ability to solve important problems, *it is critical to invest in strategies that will open not only the data, but also the space of problems, for exploration by citizens, government agencies, vendors, suppliers, and other stakeholders.* We believe that this need will be the key driver in the evolution of the open data ecosystems into systems of innovation, which in turn will become a critical part of how cities and governments operate, innovate, and solve problems in the future" (emphasis added).

Morelli et al. (2017, pp 4) posit that in order for open data to become the base "of a new generation of public services that is directly defined, designed and used by citizens", communities need to be activated and built around open, to create rules and practices for the use and

management of this resource in sustainable ways. To this extent, deepening a shared understanding of open data as a commons and communities-of-practice of/for open also as a commons can yield positive insights for value generation and sustainability of OD Ecosystems (Id). European projects such as Open4Citizens and DECODE have produced rich empirical insights on these aspects, which in turn provide rich sources for the extension of commons-based governance principles to OD Ecosystems.

3.2.1. Data commons

Ostrom's work on the commons has since been extended to other intangible resources such as data, scientific information, and knowledge. In the context of data commons literature, Purtova and van Maanen classify this literature into five categories so as to render this disparate literature productive (Purtova and van Maanen 2023, p. 23-24). The five strands are:

1. naturalist approaches to data commons,
2. information or data-commons for broader societal goals,
3. governing the knowledge commons,
4. commons-based peer production, and
5. the relational data commons.

The naturalist approach applies the theory of commons directly to data as a common-property resource. The information or data-commons for broader societal goals instead considers data as instrument for the achievement of other societal goals, such as knowledge creation or innovation, and considers these societal goals as a commons (e.g. – the scientific knowledge commons). Literature on governing the knowledge commons is less concerned with what the common property resource is, and more concerned with how resource *become* a commons if they are governed collectively. In commons-based peer production, the commons serve as a normative argument for collective access and peer production of information, where information is a 'public' good. Finally, the relational data commons also serve as a normative-political argument for the creation of commons, but where the focus is on both data, and relationships and path-dependencies between data and society.

Purtova and van Maanen argue that certain strands of data commons acknowledge the complexity of the data-related problems and focus on "the broader societal, technical and economic context of production and use of data in connection to broader societal goals"" (Id., pp 43). In terms of governance, they argue that "*the non-naturalist commons accounts inspired by Ostrom [i.e. the literature under the data or information-commons for broader societal goals strand] and to some extent the relational commons literature [are] especially compelling since they are not data-centric and account for the instrumental role of data in a digital society where values at stake are more complex than pure data provision and availability, and data is but one part of a complex ecosystem sustaining those values*" (Id., pp 53).

The non-naturalist commons strand of literature is in the context of knowledge commons, and the relational data commons literature is in the context of the digital commons. However, both sets of literature acknowledge data as an 'actant' in respective commons. For instance, Hess and Ostrom refer to the need to think beyond 'resource system' and 'resource units' in the context of a knowledge commons (Hess and Ostrom 2007, p 47). Instead they refer to constitutive resource-components of a knowledge commons using three terms – ideas (intangible content such as thoughts and innovative information, which constitute the nonphysical flow units), artifacts (the discreet, observable, nameable representations of ideas such as databases, articles, books, blogs, etc), and facilities (infrastructures that store artifacts and make them available) (Hess and Ostrom 2003). Dulong de Rosnay and Stalder similar adopt a broad definition of the 'resources' of a digital commons as "*data, information, culture and knowledge which are created and/or maintained*

online, and shared in ways that prevent against their enclosure and expand digital rights" (Dulong de Rosnay and Stalder 2020, p. 2).

Extending a relational approach of the knowledge/digital commons to data commons, it is clear that the 'resource system' of a data commons is data plus a community of shared values plus a set of social protocols for managing appropriation and provision of data (modified from Bollier 2014, p. 15). Further, in this framing, data commons are not merely neutral vessels of organizing society, but also serve as a political call and as such, bear a constitutive function (Bollier in Hess and Ostrom 2007, p 44).

Data commons bear many characteristics of a knowledge/digital commons and can be governed akin to a commons, but certain components of a data commons may be different.

- For the purposes of institutionalized governance of both the knowledge commons and the digital commons, identification of a 'community' and the creation of community boundaries is not easy (Dulong de Rosnay and Stalder 2020, p. 7; Hess and Ostrom 2007, p 48). Given the broad understanding of a 'resource' for the purposes of these commons, the community in relation to the resource is neither fixed, stable or homogenous (Hess and Ostrom 2007, p 48-51). One way to both empirically study digital commons as well as design governance frameworks based on community boundaries is to focus on the actors in relation to the resource in question (Dulong de Rosnay and Stalder 2020, p. 7; Purtova 2017, p. 197-201; Ada Lovelace Institute, 2020; Bloom et al., 2021). In the context of digital commons, boundaries are set not only by providers or contributors of the resource, but also by users and appropriators (Hess and Ostrom 2007, p 48-51). Further, depending on where boundaries are drawn, there could be overlaps between different digital commons. These overlaps could be based on commonality of actors or nested along local-global spatial axes or short term-long term temporal axes. Purtova for instance, has argued that boundaries of a data commons can be set using the boundaries of a community of people that produce data in a certain context and are affected by it (Purtova 2017, p 199-200).
- Hess and Ostrom identified three levels of rule-making for knowledge commons – operational rules (i.e. interactions between individuals for day-to-day decisions about appropriation of the common-property resource), collective-choice rules (i.e. interactions between individuals for making rules at the operational level), and constitutional rules (i.e. rules that define who can and cannot participate in making collective choices) (Hess and Ostrom 2007, p. 50-53). This is derived from the concept of polycentricity, which in turn argues that a political system with multiple centres of power at different levels provides more entry points for both citizens and public bodies to collaborate (Polanyi 1951, Ostrom 1990, McGinnis et al. 2020).

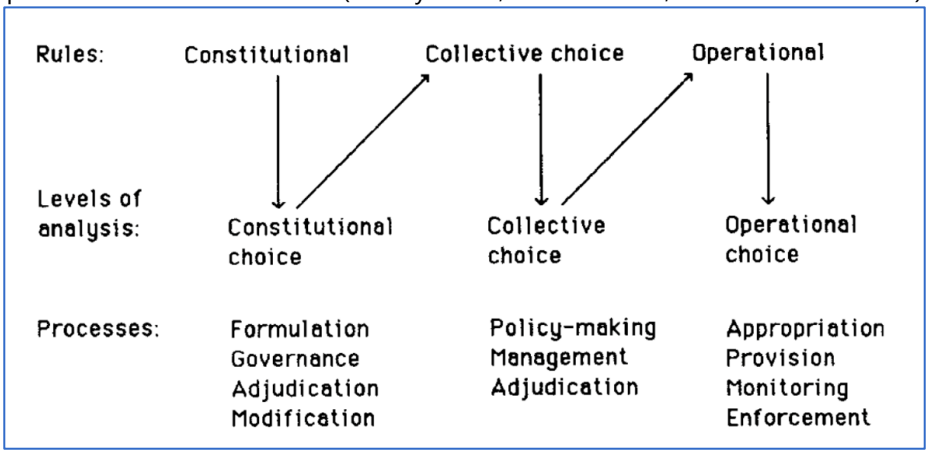

Figure 3: Linkages between rule-making systems in a commons[3]

[3] ELINOR OSTROM, GOVERNING THE COMMONS (1990), P 53)

- Rules-in-use of the digital commons comprise of normative principles that determine the actions of different actors. These normative principles can be outlined in formal laws or can be social practices that become or bear the traits of normative principles.
- Finally, "[*in] order to sustain their activities, digital commons projects can rely on each other: as Ostrom had identified, smaller, local communities need to be embedded, and interact with broader networks, towards a fruitful ecology of interoperable projects likely to collaborate, reuse parts and rely on each other, pass the threshold of local micro-initiatives, perhaps develop joint advocacy activities in order to have legal regulation recognise the needs of the digital commons"* (Dulong de Rosnay and Stalder 2020, p. 7).

3.2.2. Governance of OD Ecosystems as relational data commons

The sections above put forward arguments on the need to co-create and co-produce value in/by OD Ecosystems, and the reliance on commons-based governance principles for activating communities to co-create and-co produce value of/from open data. This section attempts to merge relational data commons with OD Ecosystems to create what this report provisionally refers to as open data commons, and then explicates each commons-based governance principles for OD Ecosystems.

Open data commons:

First, recognising OD Ecosystems as relational data commons involves actively and continuously recognise the politics of such ecosystems. This includes the politics of open data production, open data commodification, and the politics associated with 'open' and open data (see generally, van Maanen and Artyushina, 2023a; van Maanen and Artyushina, 2023b). Relatedly, governance of OD Ecosystems as relational data commons is also a manifestly political call to action, in opposition to state-led and market-led approaches to governance of open data initiatives. This political vision is aimed at creating and sustaining relational data commons as part of a "participative, democratic and ecological society" that supports European fundamental rights (Dulong de Rosnay and Stalder 2020, p. 10).

Second, applying the broad construction of 'resource systems' of relational data commons to OD Ecosystem implies that the resource system in focus is comprised of: (i) open data, to also co-create and co-produce value; (ii) a community of practice in relation to open data, which includes the traditional providers of open data i.e. governments, but also citizens, companies, and open data intermediaries as both users as well as providers of open data; and (iii) a set of infrastructures and protocols for generating, sharing, using and re-using of open data which are both (recursively) informed by and contest the political economy within which they exist (modified from Taylor and Purtova 2019 - "*Scientific knowledge commons, according to Hess and Ostrom, comprise three elements: ideas, artifacts (e.g. scholarly publications), and facilities (e.g. libraries) (2003, 2007). Data is similarly a complex resource ecosystem that includes individuals and groups, in relationships with each other and digital infrastructures and institutions in a society, all of whom generate data and are affected by it. We consider these and not data alone to be a common resource*")

Third, merging an 'ecosystemic' approach to open data with polycentricity and the conceptual framework of relational data commons implies recognising the complex interdependencies and path-dependencies among the various actants of OD Ecosystems, and using commons-based governance principles to create and preserve a "fruitful ecology of interoperable projects"

Commons-based governance principles applied to OD Ecosystems:

From this perspective, the list (modified from Dulong de Rosnay and Stalder, 2020) below captures key conceptual aspects of extending commons-based governance principles to OD Ecosystems

(see also Ada Lovelace Institute, 2020; Bloom et al., 2021; Linåker and Runeson 2022) Empirical observations on these conceptual aspects are outlined in Sections 4 and 5 below:

- **Clearly defined boundaries**: As argued above, an ecosystemic approach to open data visibilizes the heterogeneity of actants in/for an open data initiative. Similarly, relational data commons also recognise the multiplicity of actors and interactions around/enabled by data. In the context of health data, Purtova argues that the boundaries of health data commons can be drawn along health data ecosystems, which in turn are mapped by assessing who produces a certain kind of data and is affected by it (Purtova 2017, pp 199-200). Similarly, boundaries of open data commons can be drawn along the contours of OD Ecosystems, which in turn can be mapped by identifying the users, producers and intermediaries of open data and the ways in which these actors form relationships through open data. In this regard, boundaries can be inclusive as opposed to exclusive, and can be nested across regional attributes (such as local, national, regional, global OD Ecosystems) and/or other attributes (Dulong de Rosnay and Le Crosnier 2012, pp 7).
- **Participation and social norms**: Given the focus on relationality in both relational data commons and Ecosystems, participation of actors is not only dependent on access to open data and level of technical skill but is also socially-situated. For instance, a large amount of data contributed to Open Street Maps and subsequently released as 'open data' under an Open Database License is collected and uploaded by individual unpaid volunteers, which in turn impacts the gender-ratio and sexuality-ratio of volunteers as well as the epistemic provenance of the data itself (Schmidt and Klettner 2013, Gardner et al., 2020). As a result, user involvement in OD Ecosystems need to be undertaken not only through the enhancement of open data skills, but also by accounting for the power positionalities of different users in society and using, for instance, participative design methods to involve differently-situated users into co-creation of economic and social value.
- **Decision-making and monitoring**: Co-creation and co-production of values through socially-situated participation can yield participative decision-making. Further, institutionalisation of relational data commons through the use of data stewards or data trusts can ensure participation in operational, collective choice and constitutional decisions (Open Future, 2022). In this regard, the Data Republic model proposed by Calzati and van Loenen, which comprises of a public data trust, local data communes, data stewards and a board of data arbitrators could be applied to OD Ecosystems (Calzati and van Loenen, 2023). Further, democratic decision-making strategies and practices in urban data commons can also inform decision-making for OD Ecosystems (Monge et al., 2022; The New Hanse Project, 2023).
- **Political values**: While commons-based resource management is the third way, distinct from market-based and state-led resource management, the specific form of commons-based resource management depends on political values. For instance, specific choice of property rights management, through the use of either ownership or collective guardianship, depends on the political value(s) of the community (Tréguer and Dulong de Rosnay, 2020).
- **Applicable legal frameworks**: Dulong de Rosnay and Stalder (2020, pp 9-10) acknowledge the difference between open data (i.e. data available to all) and data commons (where differentiated access regimes can be applied for members of the data commons and for outsiders). At the same time Dulong de Rosnay and Stalder (2020, pp 9) on the one hand caution against the centralisation of data in hands of a few private players, and Bates (2012) on the other hand urges criticality when valorising the zealous participation of governments in the open data movement as this valorisations masks the political economy of marketisation of public services where the beneficiaries of open government data are commercial entities, and not citizens. In this dichotomy, legal mechanisms such as the EU PSI Directive which mandate free access and re-use of 6 categories high-value datasets under open standard licenses can be combined with non-traditional data-commons licenses for other categories of data such as personal data commons licenses which govern re-use of personal data and mixed data (Benhamou and Dulong de Rosnay, 2023) and copy-left licenses for certain databases

which limit commercial exploitation of the databases to certain types of cooperatives (modified from Coopyleft License, 2018). Further, a commons-based approach does not by-default 'close' data, but rather allows for a multiplicity of legal frameworks that account for different types of data relationalities to exist together and work towards the opening up of more data as open data. The multiplicity of legal frameworks also allows for dynamic adaptive governance, which is necessary for sustainability of the commons (Dietz et al. 2003, 1909). Political values together with institutionalised decision-making structures can also facilitate the use of social licenses for data re-use, i.e. licenses that "*capture multiple stakeholders' acceptance of standard practices and procedures to facilitate responsible data reuse*" (Verhulst and Saxena, 2022). These social licenses can also be negotiated, as was done by the City of Barcelona through the inclusion of 'technological sovereignty' clauses in procurement contracts with private vendors for public services, which required such private vendors to mandatorily share data with the City, which could in turn publish such data as open data on its data.gov portal (Monge et al., 2022). Annex III presents a summary of key European legal instruments that can, in different permutations and combinations, serve as legal mechanisms for commons-based governance of OD Ecosystems.

- **Fruitful ecology of interoperable projects**: From the perspective of data ecosystems, Bloemen et al. (2022) argue that existing regulatory approaches to interoperability in the European Union are focused on competitive interoperability, i.e. regulatory focus on a single platform or service being made interoperable. By contrast, they argue for generative interoperability - a broader approach to interoperability which applies to all actors in an ecosystem, to ensure not just technical interoperability by a single large platform, but to use interoperability as a starting principle to create an open online ecosystem as well as co-create new markets. Linaker and Runeson (2022) refer to the need for interoperability, to ensure the OD Ecosystems can connect to and relate with one another, thereby ensuring circularity across ecosystems. This is being recognised in regulatory frameworks such as the proposed Interoperable Europe Act, which seeks to ensure interoperability and collaboration between public bodies in the EU.
- **Sustainability of the common-property resource system**: The commons-based governance framework was theorised to ensure sustainability of shared resources, where sustainability is understood as use of the resource without degrading its quantity or quality (Gardner et al. 1990; Ostrom et al., 1994). This has since been applied to data ecosystems, to devise governance strategies that ensure sustainability of the data ecosystem (i.e. of data and of infrastructures) together with certain social values and interests just as fairness, equity, and non-discrimination (see Taylor and Purtova 2019). Commons-based governance principles enable value co-creation and co-production, which are important to ensure circularity of value – an aspect that is increasingly being discussed in the context of open innovation (see Curley and Salmelin 2013). Commons-based governance principles also ensure collective decision-making regarding the human and financial sustainability of the commons (see Dulong de Rosnay and Tréguer, 2019) and its underlying OD infrastructure as shared decision need to be made to ensure maintenance, such as OD update.
- However, underutilisation of data commons on account of enclosure strategies adopted by data platforms (such as databases) has been identified as a sustainability concern (Hess and Ostrom 2005), which can be extended to OD Ecosystems as well. In this regard however, the EU's regulatory focus on interoperability of data systems of public sector bodies combined with the regulatory focus on dismantling infrastructural control exercised by gatekeepers of the Internet is promising. On the other hand, polycentric governance for information/data commons with inclusive boundaries presents risks associated with degree and quality of participation over time (see e.g., Vitali 2018), which can also be extended to OD Ecosystems. Collaborative decision making to ensure both short-term and long-term shared decision making is particularly important in this regard (Linåker and Runeson, 2022).

3.3. Some benefits and challenges

An ecosystemic approach to open data initiatives recognises the heterogeneity of actants necessary for the generation, use and reuse of open data. Governance of OD Ecosystems as relational data commons preserves this heterogeneity while providing for a framework for collaboration among these actants to co-create and co-produce shared values in relation to open data as well as create and preserve open data. Further, given the flexibility in implementation the commons-based governance principles, governance frameworks based on such principles provide space for a mix of context-specific situated strategies and collaborations for the generation, use and re-use of open data. A commons-based approach in this regard does not serve as a prescription for certain types of data sharing or open practices. Rather, a commons-based approach recognises the importance of different types of collaborations and considers each of these as integral to the sustenance of open data commons. As Tarkovski and Zygmuntowski note, "*these initiatives [are] fellow travelers, engaged in a productive dynamic that serves to enrich the data commons movement*", which applies to open data commons as well (Open Futures 2022, p. 9-10).

Further, application of commons-based governance principles to OD Ecosystems can illuminate the ways in which values are co-created and co-produced by actors of the ecosystems. Deciding to follow commons-based governance principles also has the consequence for the communities to think, discuss and define collectively what constitute their shared political values, and what are the best avenues to collectively attain and sustain them (Dulong de Rosnay and Tréguer, 2019). Values stem not only from the economic and social impact of the data, but can also be implemented while "commoning", when making choices related to the impact on the environment, to the participation in decision-making, in the representation of the selection of data, in the legal values which will derive from the applicable legal framework.

The historical literature on how commons-based governance has addressed the appropriation and enclosure dilemma can guide resolution of the exploitation, appropriation and infrastructural control dilemmas in open data commons. For instance, land law and fishing laws developed as legal tools to address the exclusion of appropriators from a land or fishing-basin. Similarly, in free software, cultural and digital commons, licenses were adopted as legal tools, but the purpose was modified – these licenses sought to include more content into the commons, and sought to encourage content-creators to share content in more inclusive ways in order to contribute back through copyleft or Share Alike provisions applying to derivatives, ensuring the flourishing and sustainability of the commons. While the Share Alike clause does impose a restriction of derivatives, i.e. by requiring derivatives to be subject to compatible licenses and therefore limits the ability of re-users to place derived datasets in the public domain (under a CC 0 license), it has been included in the definition of open and is considered an 'open license' as it encourages a feedback loop of open data (ODI, 2013; ODI, 2015).

Further, to address privacy concerns particularly with the use of sensors and miniaturized technologies to generate open data, open licenses modified to include privacy pledges and a commons-based model of collective decision making through the use of data trusts can empower individuals to make deliberate decisions about re-use of mixed data (i.e. a combination of personal and non-personal data) (Benhamou and Dulong de Rosnay 2023). This can serve as a strong alternative to the status quo, where data protection is often used as a shield by data holders (often for-profit data holders) against contributing more of their data as open data.

Even commons-based data sharing licenses can have positive effects for OD Ecosystems. For instance, a group of individuals came together to create SalusCoop – a commons-based health data sharing infrastructure that allows citizens to exercise greater control over use of their own health data for research (SalusCoop, 2016). SalusCoop is set up as a cooperative, and each citizen

who joins the cooperative becomes a cooperative member. These cooperative members can pool in their data and authorise the cooperative to act on their behalf and share this data with health researchers on terms collectively decided by the cooperative members. In terms of governance, each cooperative member can "*contribute to set research agendas by (i) donating their data to specific research projects and (ii) taking part in decision-making processes through which the cooperative chooses which research projects should the data be granted to*" (SalusCoop, 2016, p. 33). The cooperative also created its own data sharing license, which contains a stipulation on derivatives. It states that *"[t]he results obtained through the data will be published openly - free access and consultation for anyone who wants to know them, in an anonymized way*" (Salus CG License v.1.0). In this way, a commons-based license encourages the contribution of data (including personal data) back into the feedback loop.

Finally, in terms of sustainability, commons-based governance frameworks can contribute to sustainability of OD Ecosystem, if sustainability is understood as the result of four features of The OD Ecosystem – user-driven, inclusive, circular and skill-based (van Loenen et al., 2021). The focus on collective decision-making and interoperability through commons-based governance are particularly useful in ensuring sustainability of OD Ecosystems. Further, the use of appropriate legal mechanisms, in particular a combination of open licenses together with other legal instruments/tools, can ensure fair data sharing and ensure the feedback loop of open data. Further, participation combined with appropriate institutional mechanisms for decision-making and monitoring enable user-drivenness and inclusivity. Accounting for social-situatedness of participation and political values visibilizes skill disparities and encourages a focus on skill development.

Despite these benefits, application of commons-based governance principles to OD Ecosystems also poses some challenges. First, while a commons-based approach recognises and respects collective locally-grounded approaches to governance, these collective approaches cannot and should not bypass or exist outside the rule of law. For example, while the Wikimedia community has its own rules for contribution of content and quality control, this community is still required to respect the rule of law on removal of harmful speech. The community could devise its own tools and processes for identification, investigation and removal of harmful speech, but the obligation to do so cannot be avoided (Clark et al., 2019).

Second, a political vision of relational data commons that mounts a challenge to data capitalism can quickly become an unrealistic vision. In the context of the digital commons, researchers and scholars point to the ways in which digital commons projects co-create value and value perceptions in stark contrast to capitalist perceptions of use and exchange value, these projects nonetheless interface with the market and the state to "*generate livelihood opportunities for the community and expand their influence"* (Pazaitis et al., 2022. See also a comparative survey of 10 procommons digital projects in Barcelona by Fuster Morell and Espelt, 2018). Further, Potts et al. have illuminated the economic incentives for private actors to contribute to data commons where they define data commons as "*pools of data, information, and/or knowledge, that are (1) digitally stored and transferable and (2) can be accessed by anyone for any purpose without payment and without limit*" (Potts et al. 2023). However, the extent to which commons-based OD Ecosystems can (and should) similarly interface with the market and the state needs to be studied further.

Another challenge is that a commons-based governance framework for OD Ecosystems does not present a clear answer to the problem of scale. Many sustainable natural resource commons and data commons are viable owing to their small/local scale. These are, for example, the farming and fishing commons studied by Elinor Ostrom. They are governed by local rules, possibly sectorial regulations such as national land or regional fishing law, while in the digital realm, which is global and intangible, resources are governed by copyright and other largely internationally rather

harmonised regulations, and the arrangement at the local level is open licensing, a private rule which is intended to apply globally. Given their local context, it is easier to identify the community for such commons and often the community itself is homogenous in nature, simplifying the rules-in-use for addressing the appropriation and enclosure dilemmas. But, as Ostrom and Hess note in the case of the knowledge commons, the community of such commons is difficult to identify and even where identifiable, is quite heterogenous. Having said that, several urban data commons can serve as sources of inspiration for relational data commons at scale, including (open) data commons given the centrality of open data to urban data commons (see e.g., de Lange, 2019). Further insights on scalability open data commons are proposed to be developed in Work Package 3.3, where the governance framework proposed in this report is iterated.

4 Methodology

This report has been created using the Delphi Method. This method is increasingly popular in the field of public policy (Linstone and Turoff eds, 1975). It is an iterative method for arriving at 'solutions' for a problem, particularly useful when solutions are sought to be derived from interdisciplinary fields of knowledge (Fish and Busby, 1996). The problem at hand in our study is how to sustainably involve producers and users in the open data ecosystem.

For deploying the Delphi Method, a structured group of experts is required. In our case, the experts are Early Stage Researchers of the ODECO consortium (specifically, ESRs 1,6,9,10,11,12,13,15), supervisors from ODECO beneficiaries, and representatives of ODECO partner organizations, while we, ESR 3, ESR 4, SESR 3 and SESR 4 are the lead authors of this report and thus, the facilitators of the Delphi Method.

Since typically the Delphi method consists of multiple rounds, our approach consisted of 2 rounds: an initial round of feedback received from the ODECO Consortium, and a second round of collective evaluation of the proposed governance model. The steps involved in this report include kick-off, literature analysis, expert responses, empirical data analysis, governance framework development, expert evaluation. The following subsections present each round in detail.

4.1 Kick-off

During a consortium training week (September 2023, Ascoli Piceno, Italy), the lead authors facilitated an in-person kick-off meeting where the deliverable description of actions, methodology, task division and management plan were discussed and agreed with all consortium beneficiaries and ESRs involved in this deliverable, as experts. Moreover, during the kick-off the lead authors facilitated a round table discussion and a brainstorming session with all experts.

During the round table discussion, the following principles of commons-based governance were emphasized as starting steps for developing a governance framework for OD Ecosystems, which helped position and scope the deliverable:

- Governing and regulating OD Ecosystems considering global versus local practices.
- Motivations for opening or closing data, according to the user groups represented by experts.
- Problematization of value of data, beyond financial benefits.
- Power dynamics, decision making and participation.
- Boundaries of OD Ecosystems.
- Legal mechanisms, bilateral arrangements, collaboration.

The brainstorming session approached the perspectives of each user group represented by experts, considering challenges and strategies for sustainably involving users in OD ecosystems. The brainstorming was facilitated by whiteboard and post-it notes, which captured the expert contributions to the structure and scope of this deliverable. Written notes from the brainstorming, together with audio recording from the brainstorming and the round table discussions taken with the permission of all experts present were further used in the next round of Delphi of data analysis.

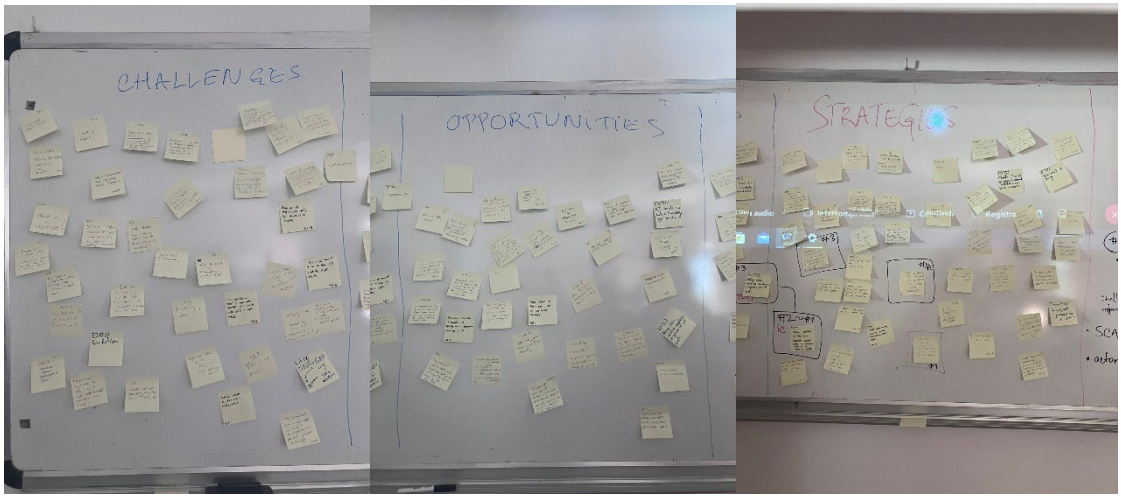

Figure 4: An overview of the notes contributed by experts during the brainstorming session.

4.2 Literature analysis

By performing content analysis on the materials captured during the Kick-off, the lead authors captured the following themes:

- Ecosystemic aspects related to open data
- Open data aspects, initiatives, openness
- Co-creation and co-production of value; social value
- Informal collaboration, stakeholder engagement, participation
- Communities, bilateral agreements versus top-down legal approaches

Using these starting themes, we performed a literature analysis which synthesizes theoretical insights from the ecosystems, data ecosystems, open data, commons. We present the results of our analysis in Section 2, consisting of an overview of the concept of data ecosystems, governance, and data governance, and we elaborate on the need for a commons-based perspective to governance of OD Ecosystems. In Section 3 we conceptually synthesize the theoretical overview with the commons-based perspective into a set of commons-based governance principles to OD Ecosystems.

4.3 Expert responses

Based on the theoretical principles of data ecosystems, OD ecosystems and governance discussed in Section 2 and the conceptual aspects of extending commons-based governance principles to OD Ecosystems discussed in Section 3, we engaged in empirical data collection involving several ODECO researchers The objective was to identify instances and practices of commoning and commons-based governance in the data ecosystems studied by Early Stage Researchers and other members of the ODECO Consortium.

For our questionnaire, we sought to evaluate the suitability of Ostrom design principles as applied to certain data commons, to address user needs for OD Ecosystems (See Ada Lovelace Institute, 2020; Bloom et al., 2021), Linåker and Runeson, 2022). The questionnaire was structured around the eight central topics:

- Challenges and opportunities for open data
- Ecosystem boundaries
- Power and decision-making
- Collaboration in data ecosystems
- Social norms and Political values

- Legal mechanisms
- Advocacy
- Governance models

The questionnaire was circulated to the experts on September 27, 2023. A copy of the questionnaire is attached as Annex I to this Report. We received a first round of responses from our experts by October 20, 2023. A copy of all responses received is attached as Annex II to this Report.

4.4 Empirical data analysis

We performed content analysis on the responses received which helped contextualize the theoretical concepts previously synthesized. Table I presents a summary of the responses received.

Table 1: Summary of experts' responses

Ostrom Design Principle	Summary of responses
Data ecosystems and its boundaries	While the specific conceptual understanding of data ecosystems adopted by ESRs is different, some key aspects could be distilled from the different understandings. • One commonality is the heterogeneity of actors that interact with each other in relation to either data more generally or open data more specifically. • Another aspect is the importance of studying technical aspects of data ecosystems together with human/social interactions with and around these technical aspects. • Value creation is defined among the heterogenous members of a data ecosystem. Boundaries are contextual and depend on various factors such as the data domain, geographical context, purpose of use, political context, organizational context, as well as the technology use and the scale of the collaboration. Some boundaries are made from *within* the data ecosystem, while in some cases the boundaries come into existence as de-facto objects of analysis. It's also important to distinguish between boundaries of a data ecosystem and boundary objects. E.g. - Esri's ArcGIS software allows users to access and use open data, but the software is not the boundary of Esri's open data ecosystem. Esri UK works with the Met Office to develop GIS-based climate change teaching resources using the latter's open data, but the teaching resources is not the boundary of Esri UK's open data ecosystem.
Communities	• Communities can form around a shared purpose. Shared needs can create communities. Datathons can also serve as meeting spaces for the creation of a community around a specific issue. Similarly, in the OpenStreetMap (OSM) ecosystem, various humanitarian communities have been formed to address a shared human rights issue like female genital mutilation or arrange assistance road delivery after a natural disaster. • Communities can also form by practice. For example, in geospatial data domains, actors consider themselves a

Ostrom Design Principle	Summary of responses
	community at the local, national and international levels. Some scientific communities are also constituted around the sharing of scientific data of their subfield (Polar commons) • Context-specific communities are visible in certain domains. For example, in learning ecosystems, we encounter school communities, local communities and communities of practitioners or experts. Communities also serve as sources of knowledge and information for actors within a data ecosystem and as such, collaborative communities come into existence. For example, journalists seek assistance from their audience for data collection and validation in the data journalism lifecycle, as observed in cases like The Guardian's collaborative data analysis effort involving their audience, which loosely represents a collaborative community.
Participation and decision-making	Decisions are made differently in different data ecosystems. • In the OpenStreetMap community, decision-making is more collaborative while in the context of non-profit organizations (NPO) decision-making is largely top down owing to a lack of resources for NPOs to survey communities or conduct interviews to identify community viewpoints. • In the open government data context – decision-making is more collaborative in the local government data ecosystem. However, besides the provision and use of open data, central and regional governments also function as policymakers as such, "*define OGD overall strategies, access rules and accompanying policies (e.g. participation mechanisms)*" (p.3). This role of policy-maker results in orchestrating activities of the other actors that are part of the open data ecosystem. Apart from the role of communities, decision-making also depends on various other aspects. In education ecosystems, decisions are widely dependent on aspects such as educational policies, guidelines, pedagogical approaches, access to data, technology -the actors who make decisions typically collaborate based on the aspects they should decide upon. Within Esri different groups of actors (data providers, intermediaries, and users) make decisions about open data. Data providers make decisions about data they provide, Esri and distributors make decisions about what data to include in their system, and end-users make decisions about what data to use from Esri's software and if they want to use those data at all. Depending on the different factors affecting decision-making in data ecosystem, decision-making can be a mix of participative and top-down. While participative decision-making is favoured, the degree to which this can be achieved and the specific issues for which participative decision-making should be undertaken

Ostrom Design Principle	Summary of responses
	are unclear. Further, it is important to distinguish between bottom-up decision making and collaborative decision-making.
Collaboration	Examples of collaborations: • In the local government context, collaboration occurs to further the interests of government as data providers/data curators. There are examples where a local government has collaborated with an NGO and with a citizen, where data provision was motivated by a need from their own interests. • There are informal collaborations between different actors of a data ecosystem. For example, NPOs collaborate with datathon organizers and participants to overcome the lack of resources for analysing their own data. There are also informal collaborations among actors across data ecosystems. For example, journalists often collaborate with educators by using open data for learning; they also collaborate with civic activists or hackers to analyse data and create stories with data. • Collaborations may extend beyond a specific domain, to include other stakeholders in a data ecosystem. For example, collaboration between actors in the Open Data and elementary schools' ecosystem might extend beyond the education sector to involve other stakeholders such as governmental agencies, non-profit organizations, OD initiatives, companies and communities. Similarly, in national/supra-national government contexts, collaboration occurs through partnerships to expand the actors involved in a data ecosystem. One example of collaboration through partnership is the one of the OpenCoesione in Reggi & Dawes (2022, p. 5) • There are also examples where an actor in an ecosystem performs the role of an intermediary to encourage collaborations. For example, NPOs/NGOs as intermediaries create platforms that use enhanced i.e. cleaned or aggregated OGD that would provide services that the government does not provide or improve pre-existing services (Open State Foundation, n.d.a, Mutuku and Mahihu, 2014). That can be done in cooperation with the government itself, which is in the role of the data provider (Open State Foundation, n.d.b) or with the intended user communities such as journalists, academics, or citizens as the users. NPOs organise hackathons (Johnson and Robinson, 2014) or conferences, bringing government, developers, and NGOs together as users, intermediaries, and providers. NPOs also provide data literacy and OGD awareness training for citizens to involve more diverse user groups (Open Knowledge Foundation, n.d.). Additionally, with the help of the NPOs, the engagement between different actors can help with dialogue and negotiation

Ostrom Design Principle	Summary of responses
	between the data provider and users and help OGD users enact a degree of social control over the government's spending, policies, and level of transparency (Schalkwyk et al., 2015). • Some data ecosystems have a mix of formal and informal collaborations. For example, in the geospatial domain, there are often formal operational partnerships between governments and private companies for data collection. At the same time, there are many informal community-led strategic partnerships that bring the geospatial data community together. Formal v. informal collaborations: • Often, collaborations are opportunistic, and as a result, as organic, ad-hoc and informal. For example, in datathons, the collaboration agreements are, for the most part, informal and temporary. In the education ecosystem, agreements are made very organically and based on the willingness to collaborate. For example, experts agree on joining school activities, or students agree on helping actors in their local environment to solve problems. More formal agreements could involve research or educational partnerships. In the geospatial ecosystem, different actors collaborate on ad-hoc basis for specific purposes. An example would be the collaboration between TU Delft Geomatics students with the Red Cross to provide on-the-fly maps of disaster-struck areas to facilitate emergency relief operations. Journalists often use open data for their news gathering and often use geodata to produce maps to illustrate their stories. In the past, Esri NL collaborated with a GIMA student and BNR Radio News to assist them by setting up tools for producing storyboards and maps based on open data for BNR's website. Another example of a collaboration between journalists, the private and public sector, and students was the development of the TV series 'Nederland van Boven', in which open data was visualized to provide a birds-eye view of the Netherlands • In local government contexts, institutionalisation of collaborations depends on the actors involved and on the origin of the economic resources with which the data effort is funded. But in the geospatial domain, there are examples of institutionalised collaborations. One example is PDOK, where several government organization joint forces to develop www.pdok.nl - a repository of high quality geodatasets. Another example is institutionalised triple-helix partnerships (i.e. involving public sector, private sector and academia) like the Ruimte voor Geo-Informatie (RGI) research program (app. 14 million euro program) - a collaboration between the private

Ostrom Design Principle	Summary of responses
	sector and the public sector with academia (triple helix). In this programme, an entire geo community was developed that lobbied for, organized co-funding to develop and implement research ideas. Some of the +100 RGI projects produced sustainable results, such as the RGI-006 Project delivering the building blocks for SDIs and the RGI-117 project successfully lobbying for an open data policy in the Netherlands. The RGI programme led to the development of a strong (open) geodata ecosystem in which actors knew where to find partners for future projects. Later with the Maps4Society program in 2014, this was repeated at a smaller scale.
Social norms and political values	Social norms: • Social norms motivate actors to use open data or hinder them from open data use because they represent underlying beliefs about the skills, knowledge of the users such as civil society being excluded from open data use based on the lack of accuracy of the data collected by this group. • Norms contribute to create the agenda of how data is used, for example by aligning actors to societal problems such as environmental issues and sustainability. • Norms related to social justice and intersectional issues, such as the CARE principles, challenge current practices and regulations of open data collection and use. Political values: Similar to social norms, political values guide decision making and strategy building along social justice, ethical and transparent use of open data, and increasing access to public services and technology.
Appropriate legal mechanisms	A range of regulatory instruments apply to open data. • General regulations like the GDPR are required to be adhered to across all data ecosystems. • There are also regulations specific to certain types of data. One example of legal mandate / legal mechanism for data sharing is the "Equitable Data Collection and Disclosure on COVID-19 Act of 2021". • There are also regulations for certain types of the OD Ecosystem. For example, for geospatial data, there are several hard and soft regulatory instruments. Hard regulatory instruments: At the EU-level, there is the INSPIRE directive. In the Netherlands, there is the system of key registrations (basisregistraties) that are backed by several laws. Soft regulatory instruments: The Open Data Maturity Reports of the European Data Portal have been an important driver in improving public policies to facilitate reuse of open data, and to set up open data communities in specific domains, see e.g., https://data.overheid.nl/datacommunities. • Regulatory instruments could be drafted at the federal/EU level as well as at the national level.

Ostrom Design Principle	Summary of responses
	For data sharing and data use: • Data sharing must abide by legal regulations on data protection. • In certain data ecosystems (such as geospatial data ecosystems) or in relation to certain types of data (like social media data on public health emergencies), contractual arrangements for data sharing do exist. Often, these arrangements are in place to extract data from private companies that are data holders. Some take the form of data-for-data agreements, others take the form of voluntary contributions by data holders. In some cases, data holders or data generators share all data held/produced by them under open licenses. For example, ArcGIS users can share their data in the ArcGIS system in ways they prefer, including in deciding which license to affix to their data (Creative Commons, ODbL, Public Domain etc.). Similarly, NPOs share data as open with open licensing, whether they are re-publishing governmental data, enhancing and publishing OGD, or collecting the data themselves to publish.
Monitoring	There are different degrees of institutional monitoring and community-driven monitoring in different data ecosystems. • For example, within education ecosystems, monitoring is performed by the educational institute. Here, monitoring consists of progress tracking, teacher development, student progress and resource allocation. Similarly, in datathons, project organisers are generally responsible for monitoring participating stakeholders. • In the national and regional government context, governments (or supra-national governance as in the case of the European Union) are the main actors overseeing data quality requirements and standards. However, in local government ecosystems, there are more collaborative monitoring processes. For example, in Denmark, the responsibilities for maintenance rely directly on the collaborative governmental initiative (GeoDenmark); however, municipalities keep the data ownership, meaning that in the case of data rectification, municipalities hold the accountability to rectify and validate the data. • In geospatial ecosystems, monitoring is more self-led. For example, in the EU, the Open Data Maturity Report is published each year, in which the maturity of open data is based on a self-assessment at the national level according to four dimensions. Several assessment metrics already include monitoring, such as monitoring the impact of open data reuse and monitoring the quality of data. In Esri, responsibilities are not "allocated", but "assumed" by different actors. In the OpenStreetMap ecosystem, slices of the community

Ostrom Design Principle	Summary of responses
	have developed their own monitoring processes, for example to address tagging mistakes.
Advocacy	Advocacy efforts generally follow a social responsibility and human rights or humanitarian agenda by creating more transparency in service provision, democratizing access to knowledge, open science and knowledge creation, building skills and capacities for non -expert data use.

4.5. Applicability of empirical data collected to OD Ecosystems

One of the questions posed to the ODECO consortium by way of the questionnaire circulated in September 2023, was to describe the particular data ecosystem being researched by the respondent.

From the responses received, the following types of open data ecosystems were described:

- **Non-specialist data users (ESR 1).** The research was focused on Open data hackathons and games, which involve an entire open data ecosystem. As noted in the response provided by ESR 1 - *"[such datathons may be] initiated by local citizen activists, companies, governmental entities, NGOs, or academic researchers. Hackathon organizers usually partner with other organizations to organize the event. Significant cooperation between different stakeholders happens before the hackathon itself, during the "pre-hack" phase (Jaskiewicz et al., 2018). Stakeholders may be invited to provide open datasets that can be used by participants during the event. During the hack and post-hack phases, participants may discover the need for further datasets to be opened and ask the organizing stakeholders to release this data*"
- **Local governments (ESR 6).** The study focuses on local network of actors using one type of local open government data belonging to the same data domain as studied by ESR 6. From her responses, her local network of actors relates to use of open government geographical voluntary data, where the delimitation of the local comes from the origin of the initiatives, which in her case is Denmark.
- **Students (ESR 10).** In context of education, ESR 10 adopts the concept of OD Ecosystems from van Loenen et al. (2021). Further, ESR 10's research on such type of OD Ecosystems is framed by the education system prevalent in the particular local region studied by her.
- **NGOs (ESR 11).** ESR 11 studies "*an ecosystem around and about small-sized NGOs that also have transparency or openness as one of their aims. They function as intermediaries, the government as a provider, and different communities they might be targeting as the users. There are however other NGOs that are focused solely on other social issues, and while I might bring them up using the literature, my case studies can represent only the specific type of NPO*"
- **Companies (ESR 13).** ESR 13's responses were framed from the perspective of OpenStreetMap, which ESR 13 considers to be a data ecosystem of open volunteer-contributed geographical information. In his responses, ESR 13 further notes that "*Stakeholders of different groups (citizens, companies, governmental entities, and NGOs) participate in the broader OSM ecosystem. That participation can come from providing open sources for other actors to edit the database or directly editing it with their own sources (contributing to the data), querying the database or using derived data (using the data), or developing tools built around OSM data or derived data*"
- **Regional/central government (ESR 12)** ESR 12 adopts a critical data studies perspective to OD Ecosystems, under which her research involves "*the analysis of what frame the technical aspects of open data (e.g., the open data platform, the infrastructure of data collection) through 'discursive and material components related to philosophy and knowledge, financial and politics, law and governance, practices, stakeholders and actors, geography and markets*"

(Kitchin, 2021)" She studies open data as part of complex socio-technical networks in which, as in a biological ecosystem, interactions among their members define value creation. From this perspective, she is currently investigating the Belgian Open Data Ecosystem at the National (Federal) and Regional level.

- **Data intermediaries (ESR 15)**. ESR 15, through his case study of ESRI, which has a strong understanding of data intermediaries, conceptualises the open data ecosystem "*as the network of actors that are connected to Esri through open data, directly or indirectly*" Further, ESR 15 notes that "*an open data ecosystem can be a part of multiple (open) data ecosystems – i.e. there can be ecosystems within ecosystem*"

Responses from these ESRs were considered in developing commons-based governance strategies for OD Ecosystems, since the data ecosystems referred to in these responses include/involve one or more type of open data.

On the other hand, certain responses did not specify a particular open data ecosystem that was being studied:

- **Journalism (ESR 09)** Responses provided by ESR 9 from the perspective of journalists did not outline a particular data ecosystem or OD Ecosystem that is being studied by ESR 9. Per his responses, his research "*is not particularly focused on a specific ecosystem. The aim of my research is to understand the use of open data by journalists and analyze the role they can play in the broader open data ecosystem*"

4.5 Governance framework development

Using the theoretical analysis and the empirical data analysis , we developed the commons-based governance framework for OD ecosystems.

As presented in Section 5, we combine the conceptual research on the application of commons-based governance principles with the responses obtained to our questionnaire, and we outline a first iteration of a commons-based governance model for (open) data ecosystem.

4.6. Expert evaluation

The proposed commons-based framework was furthermore circulated among the experts as well as partners in the ODECO consortium to obtain feedback in the form of a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. The feedback received is also presented in Section 5, which will serve as one of the sources for iteration of this governance model in subsequent deliverables.

5 A commons-based governance model for OD Ecosystems

From the combination of the conceptual literature and the empirical data obtained from the various ODECO partners, we can set out some suggestions for translation of the commons-based design principles into action (see also Labo Société Numérique, 2019). Feedback on the proposed governance model was also collected in the form of a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, and will be integrated in ODECO's efforts to further iterate the governance model in subsequent tasks and deliverables.

5.1 Boundary-making in relation to OD Ecosystems

Governance requires an object/resource system to be governed. Applying commons-based governance also requires clear identification of the common property resource system as well as the community responsible for managing this resource system. Because of the non-rivalrous nature of open data, it is difficult to create boundaries of an OD Ecosystem using the inherent characteristics of the resource itself. Further, an OD Ecosystem encompasses not only (a type of) open data, but also the technical infrastructures for the generation and re-use of such open data (such as open data platforms/portals) as also the relationships between various actors involved in creation, re-using and maintaining open data and these infrastructures. In the case of OD Ecosystems, the ecosystem itself can be mapped using its heterogenous actors, their interactions among each other as well as with technical components, and the values that are co-created and co-produced by such actors.

Action principle 1: To define the boundaries of an OD ecosystem, actors should be aware of the socio-technical conditions where their interactions with other actors take place. These conditions refer on one hand to social components such as historical, geographical aspects, social and cultural norms, organization norms and community affiliations, as well as practices, traditions, personal motivations and values. On the other hand, the technical aspects include soft and hard data infrastructures, interoperability practices, standards, laws and regulations. Ecosystem mapping can be done using tools from the discipline of design thinking and theoretical principles from the discipline of information visualization and communication.

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5.2 Supporting communities of OD Ecosystems

There are typically two types of communities in relation to generation and re-use of open data – communities of shared purpose and communities of practice. These communities are the actors immediately "affected" by open data in an open data ecosystem. These communities also serve as sources of knowledge and information for actors within an open data ecosystem and as such, collaborative communities come into existence.

Action principle 2: To support the formation of communities around the use of open data, actors of the OD Ecosystem should be knowledgeable of the purposes and practices that can be affected by open data. Shared purposes typically revolve around public and/ or local concerns, therefore they directly affect citizens, local communities or digital communities. Communities of practice typically form when experts, practitioners and academics explore societal problems by developing knowledge, tools, practices that address those problems. Research done in the field of participatory design focuses on empowering communities of shared purpose, while disciplines such as data science and engineering, engineering design, computer science typically form communities of practice around open data.

Refer to further reading:

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5.3 Encouraging participation and shared decision-making

In many cases, actors are part of an open data ecosystem because they are affected by decisions made by other (more powerful) actors in that ecosystem. One example is the role of students in open data initiatives created within education ecosystems. They use open data as part of school assignments but do not participate in the syllabus creation. It is therefore important to distinguish between participation – actively taking part in shared decision-making and collaboration – taking part in shared activities or workload. Further, social norms affecting participation through the form of volunteership, for example, also need to be considered.

In terms of decision-making, there are instances of formal institutionalised decision-making as well as collaborative decision-making. Collaborative decision-making is witnessed largely in local contexts, and as such is useful in local contexts. At the same time, some level of institutionalised decision-making is also important. As a result, a governance framework for OD Ecosystems must encourage collaborative decision-making for operational decisions and some collective choice-decision, but must engender a larger degree of top-down mandates for constitutional decisions – in line with the concept of polycentricity in commons-based governance – first applied to governance of natural resource systems, and later extended to digital and data ecosystems.

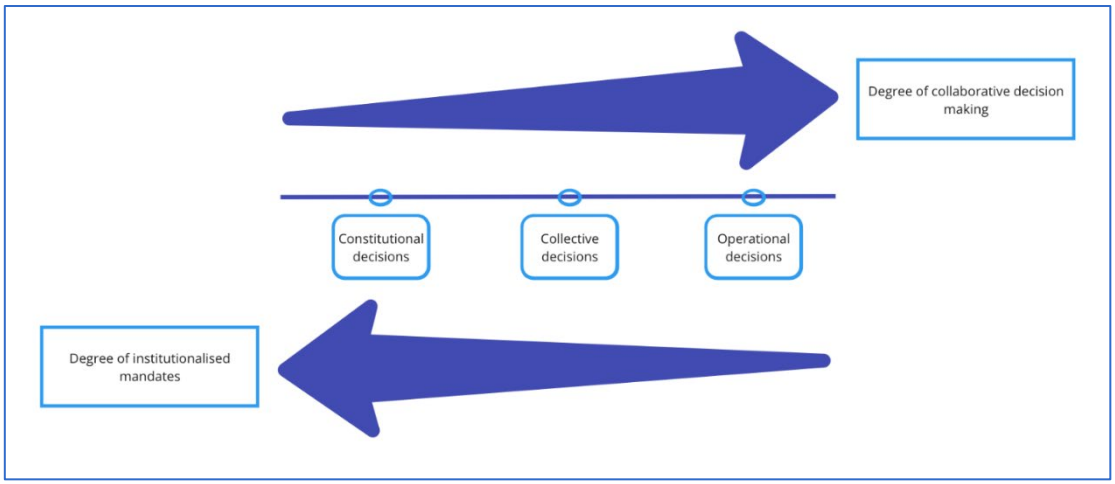

Figure 5: Visual representation of Ostrom's decision principle on nested decision-making for a commons (Figure by authors)

Action principle 3: To encourage polycentricity through participation and collaborative decision making in the OD Ecosystem, actors with more power such as institutions, organizations, communities that represent the status quo should ensure that those typically with less power such as citizens, students, research participants as well as less represented and disadvantaged groups are being actively encouraged to communicate their feedback, needs and concerns, as a first step. Moreover, they should be empowered to actively contribute to the creation of strategies and plans, practices and assessments, products and services. The discipline of (critical) data studies provides tools, approaches and theoretical concepts that challenge existing power structures and propose more just and equitable alternatives.

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5.4 Considering appropriate legal mechanisms

Many regulatory frameworks relate to open data, albeit in piecemeal fashion. Some regulations are thematic, for example data protection regulations. Other regulations are specific to certain types of data, such as COVID-19 data sharing mandates. A third type of regulations are domain-specific, such as the INSPIRE directive for geospatial data. Each of these regulatory instruments are vital jigsaw pieces for governance of OD Ecosystems.

Certain types of private legal ordering can also help address discrete issues, depending on the domain. For example, in the geospatial data ecosystem, data-for-data agreements or data-for-infrastructure agreements are common to ensure data availability. In other data ecosystems, open licenses are used to ensure circularity of data. Licenses are relevant to ensure that open data remains within the feedback loop.

Action principle 4: To encourage the use of open licenses – including open data licenses for databases, Creative Commons licenses for content, and open source software licenses for software code and other software artefacts. Licenses have been central to the creation and continuation of knowledge, information and data commons. Where the data in question does not relate to any personal or sensitive information, broad licenses should be used that impose little to no restriction on reuse. Further, governments should, to the extent possible and subject to security concerns, procure open source infrastructures for open data technologies. Here, the open licenses also serve to instil a culture of commoning.

Refer to further reading:

- Open database licenses: https://opendatacommons.org/licenses/odbl/
- Creative Commons licenses: https://creativecommons.org/share-your-work/cclicenses/
- Open software licenses: https://opensource.org/licenses/
- Alexandra Giannopoulou, *Understanding Open Data Regulation: An Analysis of the Licensing Landscape,* in Open Data Exposed (van Loenen et al. eds., 2018).
- Benhamou, Y., & Dulong de Rosnay, M. (2023). *Open Data Commons Licences (ODCL): Licensing personal and non personal data supporting the commons and privacy* (SSRN Scholarly Paper 4662511). https://papers.ssrn.com/abstract=4662511

5.5 Designing an ecology of interoperable projects

Given that boundaries of an (open) data ecosystem are fluid and contextual, there are overlaps between various OD Ecosystems as well as nested relationships between these ecosystems. There are also examples of collaborations between actors across different the OD Ecosystem. As a result, governance frameworks should encourage cross-collaborations and cross-interactions among different actors. There is a circularity inherent to the commons. This is crucial for sustainability of the OD Ecosystem.

Action principle 5: To focus on interoperability and data portability and have a broad understanding of these concepts. In particular, efforts for interoperability should encompass technical interoperability (through, for example, semantic and syntactic interoperability of open data systems/portals and through standardised formats for (open) data, as also noted in the empirical data collected) as well as generative interoperability (through adoption of policies aimed at nurturing public spaces for decision-making in relation to open data needs and challenges). Support should be provided to regulatory measures aimed at broad interoperability and portability, through advocacy and political action.

Further reading:

- EU Data Act
- EU INSPIRE Directive
- EU Data Governance Act
- EU Digital Services Act
- Alek Tarkowski, Sophie Bloemen, Paul Keller, Thomas de Groot, *Generative Interoperability*, 2022, https://www.commonsnetwork.org/wp-content/uploads/2022/06/Generative-Interoperability-Full-Report.pdf

5.6 Ensuring sustainability of OD Ecosystems

The production and use of open data is dependent on the infrastructures/assemblages of data and the actors that create, control, maintain, and repair these infrastructures/assemblages.

In this regard, economic funding for OD Ecosystems is a crucial aspect of sustainability. In addition to advocacy to ensure availability of sufficient public funds for OD Ecosystems, context-specific strategies can be adopted for determining how OD Ecosystems can interface with the market (for instance, to generate income for volunteers in certain OD Ecosystems).

Social sustainability is also equally important. In this regard, collective-action threats are significant, particularly with regard to identification and participation of communities in shared decision making.

Action principle 6: In terms of economic sustainability of OD Ecosystems, advocacy for availability of public funds can be accompanied with insights from economic and business models of digital commons/information commons/data commons projects, in particular from collaborative peer production. Contributions to social sustainability can be ensured through the adoption of critically situated approaches to participation from critical data studies.

Refer to further reading:

- Report of the European Working Team on Digital Commons, *Towards a sovereign digital infrastructure of commons* (2022)
- David Bollier and Silke Helfrich (eds), *The Wealth of the Commons*, Part V (2012).
- Keir Milburn and Bertie Russell, *Public-Common Partnerships: Building New Circuits of Collective Ownership* (2019)
- Kostakis, V., Roos, A., & Bauwens, M. (2016). Towards a political ecology of the digital economy: Socio-environmental implications of two competing value models. *Environmental Innovation and Societal Transitions*, *18*, 82-100.Bauwens, M., & Niaros, V. (2017). Value in the commons economy: Developments in open and contributory value accounting. *Heinrich Böll Stiftung, P2P Foundation*.

5.7 Evaluation of the commons-based governance framework for OD Ecosystems

In this report we introduced commons-based governance as a new perspective to the governance of OD ecosystems. ODECO researchers looking into different aspects and sectors of OD ecosystems were engaged into the validation of this new perspective, which resulted in a set of suggestions for translating the commons-based design principles into action. While we believe also other – more traditional – governance perspectives and models can be of value for the governance of OD Ecosystems, there clearly is a value in also considering the commons-based design principles.

More generally, we see three fundamental differences between more traditional and commons-based governance models, which we summarize in the table below.

Table 2: Comparison between traditional governance and commons-based governance

	Traditional governance	Commons-based governance
Main focus	Data	Data, but also relationships between actors and path-dependencies between data and society
Value of data	Value *of* open data purely in its exchange value (e.g. as a resource for innovation, competition or digital sovereignty)	Value *of* open data but also – social - values co-created and co-produced *through* open data
Governance approach	Centralized or monocentric governance, with one single centre of decision making.	*Polycentric governance,* with many centres of decision making which are formally independent of each other.

The commons-based perspective not only entails a new view on what open data ecosystems are about, but also on how they could be governed. It is important to note that the application of commons-based governance principles to OD Ecosystems also poses some important challenges, as discussed in section 3.2 of this report.

Feedback on this governance model was obtained from ODECO consortium and partner organisations. In particular, user groups of non-specialist data users (covered by ERS1), local governments (ESR6), journalists (ESR9), students (ESR10) in collaboration with partner organization CoC Playful Minds, NGOs (ESR11), companies (ESR13) and data intermediaries (ESR15), as well as the partner organization Maggioli were asked to provide a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats Analysis) of the governance model by considering the needs of these open data users. The table below summarizes our evaluation findings on the overall governance model. Individual evaluation of each action principle in the governance model was also obtained, and this is contained in Annex IV.

Table 3: Evaluation of the commons-based governance model by experts & user groups

User group	Evaluation
Non-specialist data users	The model aligns well with the non-commercial nature of citizen contributions in open data ecosystems, capturing multi-layered societal value. However, potential weaknesses, highlight the possibility of exploitation in contexts such as open data hackathons. Gender imbalances and skewed profiles among contributors are identified concerns. The model offers opportunities by valuing citizen-collected data as a complement to larger datasets. Yet, challenges include the need for appropriate rewards for citizen participation, as data collected by citizens is sometimes perceived as inferior.
Local Governments	The proposed governance model offers strengths for local governments, aligning initiatives with historical, social, and cultural norms. Emphasizing co-creation and co-production, the model enhances inclusivity and empowers less powerful groups, fostering transparency and societal benefits. Challenges include oversimplification of social aspects and potential biases in representation, while resource limitations and a lack of awareness hinder effective engagement. Opportunities lie in aligning initiatives with regional contexts, fostering informed decision-making through critical data studies, and promoting

User group	Evaluation
	interoperability for seamless collaboration. Threats encompass legal and technical challenges, such as restrictions on data sharing, compliance issues, and difficulties in ensuring data integrity, potentially limiting the model's adoption by local governments.
Journalists	The proposed governance model can be used to enhance open data utilization in journalism. Journalists recognize the need to remove obstacles from access to information, providing new possibilities to understand global challenges independently of narratives. However, in journalism, challenges arise from disorganized and hard-to-find open data, hindering effective implementation. Supporting communities through open data exhibits strengths in connecting with the academic community yet faces a weakness in the limited number of journalists involved. The principle focused on participation and decision-making demonstrates strengths in uncovering marginalized communities' issues but faces potential threats to credibility.
Students	Strengths of the model: - Potential inclusion of different users' groups with different skills. - It could be implemented in a variety of contexts and countries. - It is aligned with pragmatic and constructivist pedagogical approaches. - It supports elementary school students in an active role as users and contributors in OD ecosystems. Weaknesses of the model: - Current formal educational systems are top-down driven. - The current lack of OD skills and low capacity for using OD in school can constrain the implementation of this governance model. Opportunities: - Facilitate the appropriation of OD and Opening-up processes in schools. - Supports the implementation of sustainable OD educational initiatives. - Funding could come from public or provide sectors. Threats: - Highly abstract. It is difficult to see concretely the participation of schools and young people. - If governance mechanisms start organically within the educational system, it could be very slow.
NGOs	The model aligns well with NGOs' dual role as users and intermediaries, particularly emphasizing co-creation and co-production, fitting their societal value creation goals. However, potential weaknesses include unclear governance principles regarding NGO practices beyond political or techno-legal aspects, such as training and consultation. Opportunities arise in the framework's ability to better analyse NGOs' inputs, enhancing visibility in the ecosystem. Threats involve the potential misalignment of goals with other actors focused on economic value, necessitating the framework to account for diverse objectives and encourage cooperation.
Companies	The model's strengths lie in recognizing the heterogeneity of actors within ecosystems, acknowledging diverse stakeholder needs. It emphasizes value creation through open data (OD), enhancing commercial data-enriched services and products. Opportunities arise in creating commons attractive to commercial users, encouraging profitable contributions. Enriched OD communities benefit commercial users with more connected data, enhancing the value of their services.

User group	Evaluation
	Threats involve unprofitable participation hindering future engagement from commercial users, potentially impacting the sustainability of OD ecosystems.
Data intermediaries	The governance framework's action principles show strengths in open data intermediaries' awareness, community support, citizen communication, legal compliance, and alignment with certain business models for interoperability. Challenges include undefined boundaries, diverse community purposes, limited engagement, potential legal loopholes, and reluctance of dominant intermediaries. Opportunities involve exploring benefits of boundary-making, targeted support, inclusive business models, regulatory alignment, and leveraging interoperability trends. Threats include perceived unnecessary boundary-making, exclusion based on intermediary interests, lack of intrinsic polycentric motivation, and resistance to adopting interoperable standards. Addressing these challenges collectively is crucial for successful framework implementation within the user group.
CoC Playful Minds (partner organisation)	The proposed model exhibits strengths in fostering critical thinking, engaging with media, and aligning with global settings, supported by autonomy as a non-profit organization. Core values centred on community empowerment and social sustainability enhance its effectiveness. However, weaknesses stem from the need for improved technical skills and awareness regarding open data (OD) and their role as intermediaries in the ecosystem. Opportunities lie in fostering curiosity about OD, integrating it into diverse projects, collaborating in local communities, and creating value for schools. Threats include managerial challenges in prioritizing time and resources, power imbalances between organizations and schools, difficulties regulating power dynamics, and schools' focus on immediate performance potentially hindering collaborative efforts.
Maggioli, (partner organization)	Regarding boundaries, the proposed action principle exhibits strengths in the extensive range of stakeholders involved, including data owners, intermediaries, and various data reusers with diverse objectives, such as researchers, enterprises, data journalists, and non-profit organizations. However, challenges arise from the potentially vast open data ecosystem, impacted by factors like engagement effectiveness, data awareness, and data quality. Opportunities lie in regulatory developments and collaborative initiatives, while threats include limited enterprise participation in Italy compared to other countries, potentially restricting the overall adoption and impact of the action principle within the analysed user group. On the principle of supporting communities, Maggioli's role as a solution provider, enabling Government Organizations and Public Administrations (PAs) to open their data. Maggioli's automatic extraction tool enhances sustainability in Open Data (OD) projects, making it affordable and feasible, especially for small organizations. The potential challenge lies in maintaining data freshness over time. While the automatic extraction tool addresses initial data publishing, ensuring continuous updates might be a hurdle for organizations with limited resources. Maggioli's solutions offer opportunities for collaborative initiatives with government organizations, supporting the creation, management, and publication of data in open formats. The automatic extraction tool, tailored for small municipalities, aligns with emerging trends in sustainable and accessible OD practices. External threats may include the risk of diminished data usefulness if

User group	Evaluation
	organizations struggle to allocate resources for continuous updates. Internal challenges could arise if the automatic extraction tool faces technical issues or lacks adaptability to evolving data standards, potentially affecting the overall effectiveness of the action principle. Regarding participation, the proposed action principle addresses the needs of small municipalities in Italy, recognizing their limited resources and lack of dedicated IT personnel. The focus on automation is effective, particularly for municipalities where data publishing is not a top priority due to staff constraints. The challenge lies in engaging small municipalities and encouraging them to prioritize OD initiatives. Limited resources and competing tasks within these municipalities may hinder the successful implementation or adoption of the action principle. The opportunity exists in collaborative initiatives with larger Italian regions, allowing small municipalities to publish data on regional OD portals without the need for individual, potentially costly, portals. Integration with regional portals provides flexibility for municipalities with varying capacities and preferences. The main threat involves the difficulty of engaging stakeholders, especially in small municipalities, who may have limited awareness or interest in reusing data. Overcoming this challenge is crucial for the effective adoption of the action principle in the user group. On the topic of interoperability, we recognize the unique challenges faced by small municipalities in Italy, emphasizing the lack of IT personnel and limited resources. It acknowledges the diverse sizes and capacities of municipalities and the varying priorities for OD initiatives. A significant challenge is the low percentage of municipalities publishing OD, especially in smaller ones. Lack of standardization in data content and naming across municipalities poses a limitation for data reusers. Existing initiatives like schema.gov.it face low awareness and adoption, with few organizations possessing the necessary knowledge for semantic web applications. Collaborative initiatives can leverage the common challenges faced by municipalities. Standardizing data catalogs through schema.gov.it is a potential opportunity, although awareness and understanding of this initiative are currently limited. Simplifying data publication, such as using .csv formats, could be more accessible for organizations with basic data capabilities. The main threat involves the complexity of implementing semantic web and ontology standards, limiting their adoption among municipalities. Lack of awareness, knowledge, and resources for these standards may hinder the effective implementation of the action principle. Overcoming these barriers is essential for successful adoption in the user group. Finally, on sustainability we find relevant that in Italy, with numerous small municipalities, there's a significant opportunity to enhance the sustainability of the OD ecosystem by implementing an automated and user-friendly data publishing approach. The action principle can leverage this opportunity by promoting solutions that cater to the specific needs and limited resources of small municipalities.

From a non-specialist data users' perspective, the model can facilitate the non-commercial nature of citizen contributions, but also emphasize potential exploitation risks, particularly in open data hackathons. Local governments might align with this framework considering that it promotes historical and cultural alignment with local values, however, might face challenges considering

legal restrictions, technical interoperability issues, and compliance with data protection regulations, leading to difficulties in ensuring data quality, integrity, and decision-making. Journalists recognize the model's potential for enhancing open data utilization through interoperability, significantly enhancing transparency, accountability, and democracy by facilitating easy access and combination of data from various providers; however, they grapple with obstacles due to poor data availability, licensing.

Considering the perspective of students as potential open data users, among the strengths of this framework are the emphasis on supporting critical thinking as well as multiple collaborations between municipalities, schools and companies in an educational setting, but encounter challenges related to poor technical skills and lack of awareness of open data. NGOs see alignment between the framework and their goals towards social value creation, but face issues regarding insufficient cooperation with other ecosystem actors. Companies find strengths in recognizing stakeholder diversity but face threats from unprofitable participation to a collaboration-based governance. Finally, data intermediaries align with the principle of facilitating citizen, including disadvantaged groups, to communicate their needs and engage in decision-making, but grapple with challenges regarding the lack of motivation to adopt interoperable standards, or willingness to share part of their financial benefits to create societal value.

6. Conclusion

This report proposes a governance framework for Open Data Ecosystems (ODE) inspired by the theory of the commons and data commons as a way to steer the sustainable involvement of producers and users in OD Ecosystems. The proposed governance framework is in line with discussions that support novel data governance models emphasizing cooperation across different entities and democratic values, and in opposition to existing models of governance that centre market power of large technology companies. This is true for open data ecosystems as well, since they enable us to analyse the complex interactions among open data, its technical components, and the socio-cultural factors that shape data, creating value for individuals and society as a whole (Kitchin, 2014). An underlying theme in OD Ecosystems is the interdependence among stakeholders, underscoring a shared responsibility for the ecosystem's success or failure. The ecosystem metaphor reinforces the idea that users, technology innovators, government leaders, data managers, and policymakers are interdependent in efficiently developing the (open) data ecosystem to generate value for all participants (Harrison et al., 2012).

A commons-based approach accounts for both the economic value of open data *as well as* social values co-created and co-produced *through* open data. This approach can illuminate the ways in which values are co-created and co-produced by actors of the ecosystems. Deciding to follow a commons-based governance also has the consequence for the communities to think, discuss and define collectively what constitute their shared political values, and what are the best avenues to collectively attain and sustain them. Values stem not only from the economic and social impact of the data, but can also be implementing while "commoning", when making choices related to the impact on the environment, to the participation in decision-making, in the representation of the selection of data, in the legal values which will derive from the applicable legal framework.

However, commons-based governance brings scalability difficulties as many sustainable tangible resource commons and data commons are viable owing to their small or local context. Having said that, the Internet, Wikipedia and OpenStreetMap are three examples of large-scale global commons that show some signs of viability and sustainability based on shared values. Second, a political vision of a relational commons that mounts a challenge to data capitalism can quickly become an unrealistic vision. While considering incentives that drive the participation of different actors in a commons, it is difficult to account for commercial incentives in a political vision of an open data commons.

Based on the theoretical principles of data ecosystems and governance discussed in Section 2 and the theoretical aspects of open data commons discussed in Section 3, we engaged in empirical data collection from the ODECO Consortium. Our objective was to identify Ostromian practices of commoning in the data ecosystems studied by Early Stage Researchers and other members of the ODECO Consortium. We created a Delphi questionnaire, inspired by the Ostrom design principles as well as extension of these design principles to the digital commons. Specifically, the themes captured in our questionnaire are borrowed from Dulong de Rosnay and Stalder (2020) theorizations on the digital commons. The questionnaire was circulated to the ODECO consortium on September 27, 2023.

With the added empirical knowledge from the Delphi method, we bring forward a governance framework that builds on theoretical and empirical knowledge to propose six principles, designed as actionable items that can be used to further analyse open data initiatives:

1. Boundary-making in relation to OD Ecosystems,
2. Supporting communities of the OD Ecosystem,
3. Encouraging participation and collaborative decision-making in the OD Ecosystem,
4. Considering appropriate legal mechanisms,

5. Designing an ecology of interoperable projects,
6. Ensuring sustainability of OD Ecosystem.

Furthermore, based on a SWOT evaluation towards the applicability of this framework to user groups including non-specialist data users (covered by ERS1), local governments (ESR6), journalists (ESR9), students (ESR10) in collaboration with partner organization CoC Playful Minds, NGOs (ESR11), companies (ESR13) and data intermediaries (ESR15), as well as the partner organization Maggioli, we presented a series of gaps as well as opportunities in this framework to be further considered in future deliverables.

With this governance framework, central themes explored are the role of communities, different types of collaborations and partnerships, boundary-setting, and the use of both public and private legal ordering for collective data governance. Finally, we propose that these themes distilled in six action principles of commons-based governance for OD Ecosystems as a governance model which contributes to a more socially just, diverse, value-driven, user-driven discussion to engage diverse user groups in OD ecosystems in a sustainable manner.

This work is the first step towards a governance framework for sustainable open data ecosystems. The next steps will be performed in the workpackages 3 (T3.3), 4 (T4.3) and 5 (T5.1 and T5.3).

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Annex 1 - Delphi Questionnaire

Addressed to the following ODECO ESRs: 1, 6,9,10,11,12,13,15

(We welcome responses from other ESRs, supervisors and/or partner organisations who wish to respond on a voluntary basis)

Please answer the following questions based on the knowledge and expertise from your own research. Bring evidence to your claims through empirical data collected and analysed in your research so far. Discuss your claims in connection to literature that relates to your research. Aim for concise answers, with a length corresponding in size to your contribution.

1. Challenges and opportunities for open data

1.1 In your research thus far, what opportunities did you discover for open data?
For this question, we rely on the 'open' definition created by the Open Knowledge Foundation. Per this definition, open data is data that people are free to use, re-use and redistribute — without any legal, technological or social restriction.

1.2 In your research thus far, what challenges did you discover for open data?
For this question, we rely on the 'open' definition created by the Open Knowledge Foundation. Per this definition, open data is data that people are free to use, re-use and redistribute — without any legal, technological or social restriction.

1.3 From your research thus far, can you describe the particular data ecosystem you have been studying?
For this question, we would like to hear about your chosen conceptual framing for an 'ecosystem'. We also want more detail on the actors, processes, practices and data that constitute your data ecosystem. On the other hand, if you are not studying a 'data ecosystem', please respond stating the same.

2. Ecosystem boundaries

2.1. How would you define the boundaries of the data ecosystem you study? Are these boundaries shared and agreed upon by the actors you have come across?
For this question, we consider aspects such as geographical, historical, socio-cultural, domain-driven, organization-driven considerations that play a role in shaping boundaries for open data use, reuse, redistribution. For example, in local government contexts, boundaries could be set by the government itself, where the government creates an open government data portal for certain kinds of data providers and data users. These boundaries, however, could be contested by citizens who could argue that a certain data user has been missed out by the government.

2.2 Do any actors in your data ecosystem consider themselves or aspire to become a 'community'? If yes, elaborate on what they mean by a 'community'. For example, in the context of a local open government data ecosystem, citizens of the locality in question could consider themselves a 'community' evident from their efforts in organizing as a collective and coming together as a collective to seek good quality and accessible open data from their local government.

3. Power and decision-making

3.1 How are decisions about open data made in the ecosystem(s) you studied?

We urge you to think of this question broadly. Decisions about open data could mean, for example, decisions about technical aspects of the data, or about social aspects of use of the data. Consider the motivations behind decisions as well as the impact of these decisions for the ecosystem. Consider also 'who' makes decisions – is one actor acting on behalf of another in making certain decisions? For example, NPOs or local government could function as 'representatives' of the citizens when making decisions about open data.

3.2 Would you categorize decision-making as (largely) – top-down or participative?
By 'top-down', we mean that decisions are made in a hierarchical fashion, with one actor setting rules and the other actors following them. By 'participative', we mean that different actors come together to co-create decisions. Explain your choice by listing and describing the actors that make decisions. What role do these actors have in the ecosystem? For example, an NPO might make decisions by playing the role of a data intermediary in one instance, and the role of a data consumer in another.

3.3. Once decisions have been made and responsibilities have been allocated, what types of monitoring processes are put in place?
Here, we seek your responses on how responsibilities are divided between different actors in the ecosystem your studies. We also seek your responses on who supervises and monitors compliance with these responsibilities. For example, how is compliance by a data intermediary with a particular type of data quality standard monitored?

4. Collaboration in data ecosystems

4.1. Do you see instances of collaboration between actors of the data ecosystem you studied with other actors?
In defining their collaboration, expand on the role of these actors. For example, do you see interactions between students with the role of providers of open data and journalists with the role of users of open data, or vice versa? Briefly reflect on the impact of these roles on the ecosystem's boundaries.

4.2. When actors collaborate, what types of partnerships or informal collaboration agreements do you see them create in your ecosystem for open data?

5. Social norms and Political values

5.1 Have you encountered the presence of any social norms in how decisions are made in the ecosystem you studied?
Social norms could show up in decisions that seem "inherited" from other actors and beyond the power or agency of the actors in the ecosystems you have studied. Describe the social norms you have encountered and their impact on decision making. For example, do social norms relating to minorities or social groups impact the types of data that are collected and made open as part of an open data ecosystem?

5.2 Have you encountered the presence of any political values in the ecosystem you studied?
Political values could show up as the 'motivations' for a certain open data ecosystem. For example, many open government data initiatives are often described by government officials, in public documents or in regulatory documents as initiatives for data-driven innovation. As another example, some open data initiatives could also be described as having social justice-based motivations. In these two examples, data-driven innovation and social justice would be examples of the political values underpinning the data ecosystem in question.

6. Legal mechanisms

6.1 What types of top-down institutional-mandate driven (public) regulations are typically suggested for/recommended for the data ecosystem you studied?
Here, we are specifically interested in legislative or judicial instruments, like the GDPR or the judgment of a data protection authority. For instance, more detailed data privacy regulations are one of the legal aspects that need to be addressed for governments as users of open data. Please describe other similar examples.

6.2 Have you encountered any data sharing (private) arrangements between two or more actors in your data ecosystem?
Here, we are specifically interested in legal instruments that regulate the relationship between two or more actors, such as licenses or contracts. Please describe any license-based or contractual arrangements that you encountered that deal with sharing of data between two or more actors. By sharing of data, we mean arrangements for the input of data into an open data ecosystem.

6.3 Have you encountered any data use (private) arrangements between two or more actors in your data ecosystem?
Again, we are specifically interested in legal instruments that regulate the relationship between two or more actors, such as licenses or contracts. Please describe any license-based or contractual arrangements that you encountered that deal with use and reuse of data by one or more actor. By use and re-use of data, we mean the arrangements for processing and outputs that emerge from an open data ecosystem.

7. Advocacy

7.1 Have you encountered any advocacy efforts for open data in the data ecosystems you have studied?
If yes, can you provide more information on the type of these advocacy efforts and their impact? Consider in your response referring to the topics of social justice, environmental justice, disadvantaged groups, underrepresented communities. For example, often the lack of technical competencies is a barrier for 'non-technical users' to engage with open data. In your research, did you encounter any efforts by organizations who act on behalf of such users, to publicise these challenges and seek changes in relevant legal, political and social institutions?

8. [OPTIONAL QUESTION]: Governance models

In your literature review or from your interviews, do you have insights on the use and implementation of data governance models such as data cooperatives, data trusts or data escrows?
As an indicative source for what these terms mean, you could see https://www.adalovelaceinstitute.org/report/legal-mechanisms-data-stewardship/

Annex 2 - Responses received to Delphi Questionnaire

The received responses to the questionnaire are available upon request due to GDPR.

Annex 3 - Overview of key European legal regulations and instruments

PSI Directive

The primary regulation for open data is EU Directive 2019/1024, on open data and the re-use of public sector information ('PSI Directive'), which has since been incorporated into national laws of Member States. The primary focus of the PSI Directive is on public sector information, i.e., certain types of information (including documents and data) collected, produced, reproduced or disseminated by public sector bodies in member states. (PSI Directive 2019, Recital 8 and Article 1). Some types of information are excluded from the mandate of the PSI Directive – including documents over which third parties hold intellectual property rights, sensitive data on account of national security or statistical confidentiality, documents relating to critical infrastructures, and documents containing personal data.

For public sector information that is within the scope of the PSI Directive, the primary obligation of public sector bodies is to make such information 'open'. In this regard, Recital 16 clarifies that 'open' in this context means to make data or information freely available for use, re-use and sharing by anyone for any purpose. Recital 16 further states that –

"Open data policies which encourage the wide availability and re-use of public sector information for private or commercial purposes, with minimal or no legal, technical or financial constraints, and which promote the circulation of information not only for economic operators but primarily for the public, can play an important role in promoting social engagement, and kick-start and promote the development of new services based on novel ways to combine and make use of such information. Member States are therefore encouraged to promote the creation of data based on the principle of 'open by design and by default', with regard to all documents falling within the scope of this Directive" (emphasis added)

Obligations of Member States include:

- To ensure re-usability of public sector information for both commercial and non-commercial purposes.
- To make public sector documents available in any pre-existing format or language and, where possible and appropriate, by electronic means, in formats that are open, machine-readable, accessible, findable and re-usable, together with their metadata.
- To make dynamic data available for re-use immediately after collection, via suitable APIs and, where relevant, as a bulk download
- To make re-use subject to proportionate charges and subject to objective, proportionate, non-discriminatory, and public-interest-based conditions through the use of licenses.
- To make certain datasets (known as high-value datasets) available to the public free of charge, in machine-readable format, through APIs and as a bulk download, where applicable. High-value datasets, at present, refer to geospatial data, earth observation and environment data, meteorological data, statistics, companies and company ownership data, and mobility data.

INSPIRE Directive

The EU Directive 2007/2/EC on establishing an Infrastructure for Spatial Information in the European Community ('INSPIRE Directive' 2007) is a domain-specific regulation for spatial data.

For spatial data and metadata to which the INSPIRE Directive applies, Member States are required to operate certain services – discovery of the data, viewing of the data, download of the data, transformation services for the data, and allowing computer application-enabled operations to be performed on the data. For these services, Member States are required to "*take into account relevant user requirements and shall be easy to use, available to the public and accessible via the Internet or any other appropriate means of telecommunication*" (INSPIRE Directive 2007, Article 11(1)). Discoverability and view services are required to be provided to the public free of charge, but Member States can impose restrictions on commercial use of these services (INSPIRE Directive 2007, Article 14).

Regulatory instruments under the EU Data Strategy

In 2020, the European Commission published its vision for a technologically sovereign digital economy in the European Union. (European Commission, 2020) The aim of the strategy was to create a single market for data, based on four pillars – a cross-sectoral data governance framework for data access and use, investments in data infrastructures, empowerment of individuals (including digital literacy) and small-and-medium enterprises, and creation of European data spaces in areas of economic importance and public interest. A set of regulatory instruments have been drafted to actualize the vision of the strategy, some of which have recently come into effect.

The Data Governance Act

The newly-implemented Data Governance Act complements the PSI Directive, by setting out conditions for re-use of certain categories of 'protected' public sector data - data held by public sector bodies which are protected on grounds of (i) commercial confidentiality, (ii) statistical confidentiality, (iii) protection of intellectual property rights of third parties, or (iv) protection of personal data insofar as such data fall outside the scope of the PSI Directive. (Data Governance Act, 2022). Key obligations of member states (subject to national law) are:

- Member states are required to grant or refuse access for the re-use of these categories of protected public sector data on the basis of conditions that are made publicly available. (Data Governance Act 2022, Article 5(1) and Article 8).
- Conditions for re-use have to be non-discriminatory, transparent, proportionate and objectively justified with regard to the categories of data and the purposes of re-use and the nature of the data for which re-use is allowed. (Data Governance Act 2022, Article 5(2)). In particular, data re-use conditions cannot be used to restrict competition. (Data Governance Act 2022, Article 5(2)).
- Public sector bodies granting access for re-use are required to ensure that the protected nature of the data is preserved. This can be done through anonymisation, aggregation or creation of a secure environment for processing (article 5(3)); or by imposing confidentiality requirements on re-users (article 5(5a)); or by obtaining necessary authorisations for re-use from the intellectual-property-right holder (article 5(7)).
- Contrary to the PSI Directive, public sector bodies can charge proportionate fees for granting access to protected data. However, public sector bodies can incentivize re-use for non-commercial purposes, such as scientific research purposes, and by SMEs and start-ups subject to state-aid rules, by levying discounted fees in such cases. Data Governance Act 2022, Article 6(4)).

The Data Governance Act also prescribes regulations for two types of 'actors' that are central to the OD Ecosystem.

Data intermediation services

One set of provisions relate to "*data intermediation services*". Recital 28 of the Data Governance Act refers to data intermediation services are –

> *"commercial relationships for the purposes of data sharing between an undetermined number of data subjects and data holders on the one hand and data users on the other, through technical, legal or other means, including for the purpose of exercising the rights of data subjects in relation to personal data… Examples of data intermediation services include data marketplaces on which undertakings could make data available to others, orchestrators of data sharing ecosystems that are open to all interested parties, for instance in the context of common European data spaces, as well as data pools established jointly by several legal or natural persons with the intention to license the use of such data pools to all interested parties in a manner that all participants that contribute to the data pools would receive a reward for their contribution*" Data intermediation services include services offered by data cooperatives. Data Governance Act 2022, Article 10).

Data intermediation service providers can take any legal form or organization. A competent authority nominated by each Member State has to attest to the services provider's compliance with the Data Governance Act before the service provider can 'call itself' a data intermediation service provider. Further, Article 12 lists the conditions under which data intermediation service providers must operate, one of which is that the service provider **cannot use** *"the data for which it provides data intermediation services for purposes other than to put them at the disposal of data users and shall provide data intermediation services through a separate legal person"*

Data altruism

Another set of provisions relate to 'data altruism'. Article 2(16) of the Data Governance Act defines data altruism as –

> "*the voluntary sharing of data on the basis of the consent of data subjects to process personal data pertaining to them, or permissions of data holders to allow the use of their non-personal data without seeking or receiving a reward that goes beyond compensation related to the costs that they incur where they make their data available for objectives of general interest as provided for in national law, where applicable, such as healthcare, combating climate change, improving mobility, facilitating the development, production and dissemination of official statistics, improving the provision of public services, public policy making or scientific research purposes in the general interest"*

Member states are required to maintain a public register of data altruism organisations. To qualify for inclusion in such register, data altruism organisations are required to comply with the procedural conditions laid down in Article 19. Similar to data intermediation services, data altruism organisations are **not allowed** to "*use the data for other objectives than those of general interest for which the data subject or data holder allows the processing. The recognised data altruism organisation shall not use misleading marketing practices to solicit the provision of data*" (Data Governance Act 2022, Article 21(2)).

The Digital Markets Act

The newly implemented Digital Markets Act together with its implementing regulation regulates core platform services offered by gatekeepers. (Digital Markets Act 2022; Implementing

Regulation 2022). In this regard, large digital platforms can be designated as gatekeepers if and when such platforms (a) have a significant impact on the internal market; (b) provide core platform services which are an important gateway for business users to reach end users; and (c) enjoy an entrenched and durable position, in their operations, or it is foreseeable that they will enjoy such a position in the near future. A range of obligations are imposed on gatekeepers. For instance, gatekeepers have to: (a) allow third parties to inter-operate with the gatekeeper's own services in certain specific situations, (b) allow their business users to access the data that they generate in their use of the gatekeeper's platform, (c) provide companies advertising on their platform with the tools and information necessary for advertisers and publishers to carry out their own independent verification of their advertisements hosted by the gatekeeper, and (d) allow their business users to promote their offer and conclude contracts with their customers outside the gatekeeper's platform.

The Data Act

The latest draft of the Data Act (based on interinstitutional negotiations) lays down provisions for the extraction of value from product and related services data, i.e. industrial data. (European Parliament, 2023). The regulation lays down requirements for B2C and B2B data sharing for both personal and non-personal data, with some exceptions for small-and-medium-enterprises. With regard to B2C data sharing, where data cannot be directly accessed by the user from a connected product or related service, data holders are required to make the produce/service data as well as the metadata that is necessary to interpret and use that data, accessible to the user without undue delay, easily, securely and in a comprehensive, structured, commonly used and machine-readable format, free of charge and, where relevant and technically feasible, of the same quality as is available to the data holder, continuously and in real-time. (Article 4). Such data sharing is subject to protection of trade secrets, and data holders can enter into confidentiality arrangements with the data recipient. Similar data sharing is mandated for sharing of data by data holders with third parties (other than gatekeepers) upon request of a user. (Article 5). Further, such data sharing should be undertaken on fair, reasonable and non-discriminatory terms (Article 8). The regulation also prescribes a form of B2G data sharing, where data holders are required to share data with public bodies for exceptional purposes such as a public emergency or for development of statistics (Chapter V).

The (proposed) Interoperable Europe Act

The Interoperable Europe Act introduces a cooperation framework for public administrations across the EU that helps build a secure cross-border exchange of data and agree on shared digital solutions, such as open-source software, guidelines, checklists, frameworks, and IT tools. It will also enable them to cooperate more effectively, exchange information and ensure the seamless delivery of public services across borders, sectors and organisational boundaries. It stimulates public sector innovation and public-private "GovTech" projects.

Per the FAQs released by the European Commission, "*in the public sector, interoperability relates to the ability of administrations to cooperate, exchange information and make the delivery of public services seamless across borders, sectors and organisational boundaries. It also supports trusted data sharing and access across sectors and administrative layers in order to improve policymaking and implementation. Essentially, interoperability is about achieving common goals together, despite organisational or geographical distance between actors. Solutions in interoperability are often compared to toy bricks that can be easily exchanged, reused and connected, even if they come in very different colours and shapes*"

Examples of national laws and local policies that incentivize open data practices

EU-level regulations function as institutional mandates for the OD Ecosystem. In addition, there are also some examples of national laws that incentivize certain practices of open data.

One notable example is in the context of public procurement contracts, especially since these serve as low-hanging fruits to involve private actors as data producers in the OD Ecosystem. In 2016, the French Government introduced a national law for the 'Digital Republic'. Article 17 of this law states that where a public service is delegated, the granting authority can freely extract and exploit all data and databases collected or produced during the operation of the public service, in particular with a view to making them available free of charge for free or fee-based reuse (emphasis added). (Loi n° 2016-1321, 2016). This model of making private sector data 'open' has since been adopted by the European Union in its a policy document relating to the data strategy. (European Commission Staff Working Document, 2017; Heiko Richter, 2023)

In a more local context, the city of Barcelona also used public procurement contracts as a vehicle to implement open data practices (that align with a normative vision of a recursive data commons that centres community control over data) (Calleja-López 2018). To create the Barcelona City Commons, the city of Barcelona introduced 'data sovereignty' clauses in its public procurement contracts. As Malcolm Bain (the lawyer responsible for drafting and negotiating these clauses notes, the purpose of data sovereignty clauses was "*establish a minimum set of requirements so that the data generated as a result of these contracts is available, accessible, is privacy-compliant, enables sharing among city departments and, if possible, can be anonymised and cleaned to publish it as open data*" (Monge et al. 2022, p. 11).

Illustrations of private legal ordering though contracts and licenses

Licenses have been used as a private law-tool for achieving public interest purposes. The Creative Commons licenses were developed for content (and later expanded for databases), to allow content and database creators to keep knowledge in the commons. These licenses allow content creators to give public permissions for use and sharing of their work, across a spectrum of more restrictive to least restrictive use permissions.[4] The system of generating licenses is based on the combination of the four founding elements: Attribution (BY), No derivatives (ND), No commercial uses (NC), and Share Alike (SA), resulting in six different licenses (Giannopoulou 2018).

Inspired by the Creative Commons licenses, the Open Knowledge Foundation (OKFN) created a set of open data licenses.[5] The legal structure of open data licenses is two-fold - a waiver of copyright and sui generis database rights were permitted by national legal frameworks, and contractual licensing of rights that cannot be waived in a manner that allows for the data in question to remain in the public domain (Hatcher, 2008).

Both the Creative Commons licenses and the OKFN open data licenses seek to create a feedback loop, to ensure that the data forming subject matter of the license and derivatives of such data remain within the open data ecosystem. This circularity ensures sustainability of the (open) data ecosystem as well. However, there are certain compatibility issues with these licenses (particularly in the context of derivative content or databases) that are yet to be definitively resolved (Dulong de Rosnay, 2010). And the Share Alike provision apply to the derivatives only, justifying the

[4] "What we do: What is Creative Commons?", available online: https://creativecommons.org/about/.

[5] https://opendatacommons.org/

creation of other, more commons-oriented, open data licenses (Benhamou and Dulong de Rosnay, 2023).

Private forms of ordering that vest control for data sharing with individuals and communities have also been developed in local domain-specific context. For instance, the example of SalusCoop highlighted above is notable for health data commons. The Ada Lovelace Institute has also identified numerous data sharing initiatives that have different levels of 'commoning' as well as different levels of 'openness' to sharing of data (Ada Lovelace Institute, 2020).

Annex 4 - Evaluation of each action principle of the proposed commons-based governance model

1. Boundaries of OD Ecosystems

	Strengths	Weaknesses	Opportunities	Threats
Non-specialist data users	The inclusion of historical, geographical, social and cultural norms, reflects well the bottom-up, community based contributions from citizens. Boundaries in citizen contributions can be found both in technical terms, and in societal terms.	Ecosystem mapping tools need specific adaptations to the realm of citizen contributions, which might be harder to communicate	I do not see particular opportunities to explore	Depending on the design thinking tools and theoretical principles, certain actors might be privileged in the ecosystem mapping.
Local Governments	Understanding the context in which an ecosystem operates and the role of local government by considering various factors can help identify the factors that affect its development and usage. Technical aspects such as interoperability practices, standards, laws, and regulations can facilitate	Open data ecosystems are complex and multifaceted, making it challenging for local governments to capture social aspects through design thinking and information visualisation. Specialized knowledge and expertise may be required, and design thinking and information visualisation may not entirely	Local governments may face challenges in open data initiatives if they don't consider historical and geographical context, social and cultural norms, organisational norms and community affiliations. These factors help identify patterns, trends, and unique characteristics of ecosystems, and enable co-	To understand the barriers to applying this principle, it is important to consider several factors that can impact the availability and accessibility of data. These factors include the historical and geographical contexts in which the data is generated, laws and regulations that govern data sharing, technical challenges in integrating and exchanging data

	Strengths	Weaknesses	Opportunities	Threats
	data exchange and integration, while design thinking and information visualization techniques can improve communication and decision-making. Mapping the ecosystem can help identify opportunities and challenges, guiding the development of strategies to maximize the benefits of the open data ecosystem.	capture the subjective nature of these practices. Additionally, open data ecosystems are dynamic, making it difficult for static approaches to reflect its current state.	designing of data initiatives that resonate with the needs and aspirations of all participants. This knowledge can also lead to targeted solutions and promote acceptance within local governments. Compliance with relevant laws and regulations regarding data privacy, security, and accessibility is crucial in building trust within partnerships and collaborations.	across different systems, social and cultural norms that can limit cooperation within the open data ecosystem, and individual motivations and values that can influence data-sharing behaviours. Addressing these barriers can help local governments become more involved in an open data ecosystem, promoting greater transparency and collaboration.
Journalists	Journalists are interested in tearing down boundaries. At the moment, only a few data exist, but they provide new possibilities like understanding how communities in other countries and cultures live and handle problems and challenges without the need to relate to narrations.	Boundaries that exist at the moment are: • Open data is not organized, and journalists are unable to find them. • Additionally, data is incompatible for analysis, even if the journalists are able to find them. An example may be data for the healthcare	There are opportunities in tearing down cultural, geographical, and technological barriers as it will become easier to find and compare information.	If there are no standards applied to the available information, it will be in such a chaotic state that, in theory, it may be available. Still, in reality, it will be unusable.

	Strengths	Weaknesses	Opportunities	Threats
		system in Greece and Germany. Since there are no standard methodologies for data collection, formatting, and distribution, it makes a comparison nearly impossible.		
Students	Learning designs for OD competencies could support the interactions among different actors and set boundaries according to learning objectives.	It requires highly aware and knowledgeable teachers and students on OD ecosystems.	Gives freedom and autonomy to students and teachers.	It is challenging to expect from students at a young age to be aware of the socio-technical conditions where their interactions with OD actors take place.
NGOs	The action principle considers social components, which are especially important in the context of NGOs. Not only because of the social focus and motivations but also due to the organizational specifics.	It might be useful to consider open data skills, knowledge and awareness for the social components part as a lack or presence of these among the employees and the community they are addressing can be a part of boundary defining process.	It is a useful action principle, as NPOs, especially those with less experience with open data, can use it to understand their position within the ecosystem better. Moreover, it would be useful to bring out the role of the NGOs through such boundary defining.	Lack of knowledge or skills of NGOs and/or the lack of financial and time resources (considering their non-profit nature) can cause the lack of awareness of socio-technical conditions for boundary defining process.
Companies	OD Ecosystems boundaries are sometimes	Loose definition on how to do	Letting the actors co-decide the	A wrong understanding of the boundaries

	Strengths	Weaknesses	Opportunities	Threats
	blurry and therefore a definition is needed. Being aware of the community socio-technical conditions is an accurate way of defining it, and includes also commercial users who take part in them.	Ecosystem mapping.	boundaries of their ecosystem.	may lead to a wrong mapping of the actors and necessities of the OD Ecosystem.
Data intermediaries	Open data intermediaries in my research are generally aware of the socio-technical conditions of their open data ecosystems.	So far, I have not observed open data intermediaries in my research explicitly defining their boundaries (but they do define their boundary objects). I wonder if that is possible or necessary for them.	Open data intermediaries may explore if boundary-making is necessary and useful for them and other actors within their ecosystems and how can they do it.	Boundary-making may be deemed unnecessary by open data intermediaries (or at least, emerges organically), hence, there is no incentive for them to do it.
Maggioli (partner organisation)	Boundaries are large: data owners, intermediaries and data reusers, who could be part of different categories: researchers, enterprise, other PAs to improve their services, someone who wants to create some services for the	The ecosystem of OD could be very big, depending on many key factors: the ability to engage them, the ability to let the people know that the data exists, quality data that can be reused for many purposes.	N/A	In Italy for example, very few enterprises outside the government publish OD. One of these enterprises is Enel, an energy company. In other countries, there are more enterprises that publish OD.

	Strengths	Weaknesses	Opportunities	Threats
	enterprise or the citizens, some data journalists (very few in Italy), non-profit organizations (looking for data, campaigning for data, pushing for environmental reasons, https://www.openpolis.it/).			
CoC Playful Minds (partner organisation)	CoC has already a network. Interactions with municipalities, schools, and companies. Collaboration and projects in common with municipality.	There is a flow of data, but it is not accessible for everybody, it is not open data. Few awareness about OD. It is blurry for the organization how to engage in OD systems.	Efforts in documentation of processes and data. There is an opportunity to further develop them systematically. Co-producing documentation with schools.	Confidentiality agreements and different interest of stakeholders involved. Sometimes GDPR regulation makes interactions with other organization complicated. Overwhelmed schools with several external agents trying to interfere.

2. Supporting communities of OD Ecosystems

	Strengths	Weaknesses	Opportunities	Threats
Non-specialist data users	Starting from the societal problems as a way to build communities of practice is well suited for citizen participation. Citizen contributions are not necessarily motivated by	Participatory design disciplines and engineering and data science disciplines might have similar motivations and objectives, but different shared	There is an opportunity to different communities of practice together around shared citizen concerns, with citizens acting as problem owners.	A possible threat is the lack of recognition of citizen groups, together with their data collection activities, as real communities of practice.

	Strengths	Weaknesses	Opportunities	Threats
	anything specific to open data, but rather by the sense that data collection and sharing can meaningfully contribute to resolve a local issue.	practices. The action principle lacks a way to bring these two communities together.		
Local Governments	Recognizing communities around open data can help local governments tap into their expertise, knowledge, and diverse perspectives. This enhances problem-solving by leveraging different approaches and methodologies. Engaging with communities of practice can facilitate knowledge-sharing and capacity building. Collaborations between local governments, experts, practitioners, and academics enable them to locate relevant data, develop effective solutions, tools, policies, and practices. This	It's possible that local governments may not be aware of the benefits and opportunities that come from engaging with communities formed around open data. They may also have limited resources, including funding and expertise, which can make it difficult to effectively support these communities. This can prevent them from fully using the potential of open data to address public and local issues, leading to missed opportunities for collaboration. Moreover, they may encounter obstacles when trying to ensure the quality and accessibility of	Open data communities allow local governments to collaborate with citizens, experts, practitioners, and academics to address public and local issues. This co-creation approach enables holistic problem-solving, tailored solutions, and transparency. Participatory design empowers individuals to take ownership of solutions, fostering commitment and sustainability. Participants can share expertise and develop new knowledge, tools, and practices for relevant and effective local solutions.	Local governments must assess the potential risks associated with data privacy, inequality, and exclusion that may arise from the handling of data, as well as misinterpretation and misuse of data. They should take appropriate measures to safeguard sensitive information, ensure data privacy and security, and maintain data accuracy by providing the necessary context to prevent any potential misunderstandings or misuse. Furthermore, they should ensure that the data is representative to allow for the inclusion of all citizens and provide equal opportunities for participation and benefit from open

	Strengths	Weaknesses	Opportunities	Threats
	can foster a sense of ownership, empowerment, and active citizenship within the community.	the data they provide to communities. Issues such as incomplete or outdated data, lack of standardisation, and limited access to relevant data can undermine the effectiveness of community-driven initiatives.		data initiatives. These risks must be taken into consideration when adopting shared purpose or practice communities' approaches.
Journalists	The journalistic communities that are working with open data are very small, now they have ties only with the academic community.	There are very few journalists who are working with open data; therefore, no large communities have been formed yet.	It would be incredibly beneficial if wider communities of open data existed. Journalists will have the opportunity to reach out to experts for technical help.	No threats.
Students	This action principle underpines a holistic perspective of elementary school students as active and empowered actors in OD ecosystems. This idea supports not just a novel community of OD students, teachers, and schools, but also, local communities where students actively engage.	Current linear and top-down perspectives have seen elementary school students as merely static users of OD that need to be equipped with some skills for their future engagement in society.	Contribute to the sustainability of OD initiatives in education that are grounded on community practices and local ecosystems.	The alignment between school or academic dynamics and local community's real problems and factors. Facilitate the interoperability and communication between schools, teachers, and students.
NGOs	NGOs are a type of actor for	NGOs may lack resources	This action principle provides	Communities of practice might be

	Strengths	Weaknesses	Opportunities	Threats
	which this action principle is of direct concern. They often concern their open data projects around local issues, which can help form a community that uses open data to find a solution to this local problem. NGOs combine in themselves aspects of both communities of shared purpose with communities of practice as they aim to solve societal issues with open data skills. NGOs can also bring together representatives of these communities through the events or projects they initiate, like hackathons or meet-ups, or by creating a platform in which both can participate.	and/or skills due to their non-profit model to identify purposes and practices that can be affected by open data. Moreover, they might not have the resources to support the communities, so their contribution might be hindered.	an opportunity to better identify the role NGOs play in both being a part of the community and supporting and creating communities around open data. That might have a regulatory impact or increased funding support towards NGOs from the government to support their collaborative activities.	more equipped to form and sustain themselves as they are represented by experts, practitioners, and researchers, who are likely to have skills and knowledge about open data to reuse the data and finance their projects. However, communities of shared purpose might have more issues to overcome to form and sustain themselves. It might be that there should be a prioritization for the latter community to implement the action principle.
Companies	Communities should form around common goals and concerns, as	"To support…" How? Are commercial users included in "experts,	To learn from each other in tools and practices, therefore also	Not finding the necessary stakeholders that share a common goal.

	Strengths	Weaknesses	Opportunities	Threats
	explained in the action principle. It is broad in its shared purposes definition and its affected stakeholders (an example I discovered in my interviews: Companies [commercial users] take part and started the Overture Maps CoP = digital community, as quality OD does not exist in several aspects of the geospatial domain centered in developers = local concern)	practitioners and academics"? Are commercial problems included in "societal problems"? (as in the example shown before, lack of quality in existing data may be enough for the formation of a community)	boosting the internal organization (e.g. company) knowledge.	
Data intermediaries	Open data intermediaries in my research are already supporting other actors in their open data ecosystems to some extent.	The purposes for providing and reusing open data vary. So, open data intermediaries may not be fully knowledgeable of all the purposes and practices of open data within their ecosystems even though those in my research seem to have a good general grasp.	Open data intermediaries may design more concerted effort to support overall and smaller subgroups of communities in their ecosystem such as through public events and direct engagements.	Open data intermediaries may select actors to include in their communities based on their own interest. Hence, they may exclude certain actors.
Maggioli (partner organisation)	N/A	N/A	Maggioli is a solution provider, its role is to be a supplier and	N/A

	Strengths	Weaknesses	Opportunities	Threats
			enabler for Government Organizations / PAs, who want to open their data. We have an important role especially in the local government market (municipalities), because we provide solutions in many areas of Italian municipalities. So our solutions are to create and manage the data that can be then published in an open space. In the past we created a solution, like an extractor, a module that can be bought by municipalities. That extracts the data from our database and publishes this data in an open format on an open portal. One important feature of this extraction tool is that it is totally automatic, so you have to configure it just once, which dataset to publish, what content, and what data to	

	Strengths	Weaknesses	Opportunities	Threats
			aggregate. Once defined what to publish, this module will work in an unattended way. In my experience, it is a very important tool from a point of view of the sustainability of an OD project. Many times organizations start to publish some data, and then don't have the time or resources to keep this data up-to-date. The freshness of data is an important quality factor, is the data is not updated, it's not useful. Some of this data can be historical, but some data is changing every day, so it needs to be updated. Because our module is unattended, the OD program can be affordable for small organizations in Italy.	
CoC Playful Minds (partner organisation)	CoC works for raising the voice of children. Empowering a usually excluded user group.	As a nonprofit organization usually CoC has less power in decision-making than other	Developing methods in topics such as co-creation and co-design.	Practices and culture unknowns. Hard to create a new culture and change mindset of

	Strengths	Weaknesses	Opportunities	Threats
	CoC is creating a network around co-creating which could be seen as community of practice. Collaboration and inclusion are organizational values.	stakeholders such as municipalities and companies.		different stakeholders. Limited access.

3. Encouraging participation and collaborative decision-making

	Strengths	Weaknesses	Opportunities	Threats
Non-specialist data users	Power imbalances are a core success factor for citizen led initiatives. Local citizen initiatives often end up facing non-responsive bureaucracies which fail to publish datasets, or to respond to citizen concerns.	Citizen empowerment sometimes risks deviating into the transfer of responsibilities from designated entities to local communities which, already burdened by a local issue, now also become responsible for creating a solution. The model should take into account additional burdens that are placed on less empowered actors.	Opportunity to address power imbalances which prevent citizen contributions from achieving impact.	Obstacles are mainly about the additional burden on disempowered actors.
Local Governments	Polycentricity is a concept that allows local governments to promote inclusive governance by actively involving	Collaborative decision-making processes and extensive participation require a significant amount of time, resources, and	Local governments should encourage the participation of underrepresented groups to ensure fair decision-making and	Encouraging participation and collaborative decision-making for diverse groups can be challenging for local governments due to limited

	Strengths	Weaknesses	Opportunities	Threats
	typically less powerful groups such as citizens, students, and research participants. This approach empowers traditionally less powerful groups by giving them a voice and agency in decision-making processes. As a result, it supports equity and social justice by ensuring that everyone has an equal opportunity to participate in an open data ecosystem. Moreover, engaging a wide range of participants in collaborative decision-making enables local governments to tap into collective intelligence and diverse expertise. This fosters innovation and creativity and helps local governments develop policies and initiatives that are more relevant and	coordination. This can lead to increased complexity and the need for additional resources to ensure effective engagement. Local governments must balance the need for inclusive participation with the efficiency of decision-making processes. Encouraging participation from diverse groups can lead to conflicting interests, differing priorities, and challenges in reaching consensus. Local governments must navigate these complexities and find ways to manage disagreements and conflicts constructively. Facilitating effective dialogue and consensus-building processes requires skilled facilitation and	equitable outcomes. Critical data studies can help identify and challenge existing inequalities. By gaining insights from a diverse range of individuals, local governments can develop more informed decision-making processes and policies, leading to increased civic engagement and better outcomes. Encouraging a diverse group of individuals to participate can lead to innovative solutions and better decision-making.	resources, balancing inclusivity with efficiency, and overcoming power imbalances. It requires careful facilitation and engagement strategies, investment in awareness-raising initiatives and capacity-building programs, as well as strong leadership, effective communication, and ongoing engagement efforts to foster a culture of collaboration and participation.

	Strengths	Weaknesses	Opportunities	Threats
	responsive to the needs of the community.	conflict-resolution techniques. Moreover, local governments must carefully consider the feasibility, practicality, and alignment of proposed solutions with existing frameworks and constraints.		
Journalists	Journalists can indirectly discover the problems and needs of powerless communities through analyzing open data and communicating them to the public, which can create pressure for institutions to take action.	There is no way for direct participation, and the media themselves are actors with power.	Journalists can collect data from these communities and release them to the public so institutions and established power structures can take them into account.	They can raise credibility problems for the data that the journalists collect and publish if there is no strict methodological framework for the data collection and analysis.
Students	This action principle is aligned with trends in pedagogical approaches where students are more active on defining their own learning.	Decision making in education highly depends on specific contexts (public or private) and countries. For example, some public systems give more or less autonomy to teachers, while in learner-based educational	Project-based approaches in education open spaces for reflection and higher involvement of students in their own learning. Empirical data in my research has shown incipient co-creation initiates between teachers and	Students, teachers, and school administrators lack awareness and skills related to co-creation or participatory design processes, which could facilitate decision-making in educational curriculums as a result of co-design processes instead

	Strengths	Weaknesses	Opportunities	Threats
		designs the role of learners is expected to be more active than in traditional pedagogical approaches. Interaction levels such as educational policy vs school administration, school emphasis vs teacher's autonomy and teacher's authority vs student's empowerment, make decision making very complex in education and might require different governance mechanisms.	students that drive participation in decision making.	of top-down mandates.
NGOs	NGOs, by their nature, are meant to represent groups of actors with less power in the ecosystem. They often create a space for feedback and concerns or proactively seek them from the communities. Thus, they are at the forefront of implementing this action	To empower less powerful actors to contribute more to the process that might affect them, NGOs might need more resources that they might not have. With their non-profit nature and especially if it is a smaller and/or local NGO, they are likely to be constrained by	Highlighting the importance of collaborative decision-making can firstly include less powerful NGOs in that process, which means they can represent their mission and community better. Moreover, it is a good principle to highlight existing work NGOs do to include various communities in	To include many actors in the decision-making might mean many competing views and needs that would need to be reconciled with each other. More importantly, for the inclusion of diverse groups to be possible and meaningful, they need to have a level of awareness and skills around open data that many do not

	Strengths	Weaknesses	Opportunities	Threats
	principle. Moreover, NGOs can often try and challenge other powerful actors in the ecosystem to consider those with less power in terms of regulations, data access, and data value. Additionally, depending on the scale and nature of NGO, it can be an actor with less power itself and would benefit from being included in the decision-making process.	their financial situation.	the decision-making about open data.	possess. It may require additional time and financial burden for organisations such as NGOs that may not be available.
Companies	Polycentricity. A balanced participation allows for a better outcome.	Highlights the importance of taking less represented and disadvantaged groups into account, but does not say how to implement it.	Commercial users should be incorporated in the process. How to make sure SMEs and freelancers are heard, and not only big corporations.	Still underrepresenting disadvantaged stakeholders that were not identified.
Data intermediaries	Certain open data intermediaries are already facilitating citizens, including disadvantaged groups, to communicate their needs and	Certain open data intermediaries do not work/engage directly with other actors.	Open data intermediaries may design business models that include typically disadvantaged groups in their products and services.	I do not observe intrinsic motivation/incentives for open data intermediaries "to encourage polycentricity" unless it would benefit themselves.

	Strengths	Weaknesses	Opportunities	Threats
	concerns to relevant parties.			
Maggioli (partner organisation)	N/A	N/A	We have 8000 municipalities in Italy. The vast majority of them are very small. 7000 are under 10000 inhabitants. In a very small municipality, you don't have IT people. And also very few people work at all at the municipality. They have a lot of tasks, and publishing OD is not their top priority, without an automated solution this won't work. In order to have these little municipalities, many Italian regions that are bigger and have more resources give the opportunity to the small municipalities to publish their own data on the regional data portal. It is an initiative that is put in place by around 12 Italian regions so the municipalities don't have to buy an OD portal,	From my point of view, one of the most complicated matters is to engage other stakeholders, other people that can be interested in reusing data. This is difficult already for large orgs like regions or ministry, and more difficult for small municipalities.

	Strengths	Weaknesses	Opportunities	Threats
			which could be costly. Also some municipalities publish very few datasets, they are not a big publisher. As a solution provider, we have integrated different regional OD portals. It's a choice of the municipality to publish their data on the regional OD portal, or if they want to put in place their own dedicated data portal, with varying costs between both solutions.	
CoC Playful Minds (partner organisation)	Participation and collaborative decision making are core values of the organization.	Power relations in a network of private, public, and nonprofit organizations must be considered.	Developing methods for co-creation and co-design.	Stakeholders involved in CoC projects (schools, municipalities, companies) have different knowledge and experience which could make difficult equal participation in decision-making. Stakeholders involved might have different interests and strategies which not always are aligned.

4. Appropriate legal mechanisms

	Strengths	Weaknesses	Opportunities	Threats
Non-specialist data users	From a citizen perspective, licensing is particularly important as an open license can address power imbalances and empower citizens to freely gain insights and build solutions based on open data.	The action principle fails to address the issue of cost. Understandably, some open data API and datasets are expensive to provision to the end user. Even if the infrastructure and technology is open source, it is not clear who should cover unavoidable costs related to service upkeep. Citizens have limited or no resources to pay for API access.	No specific opportunities identified.	The principle is vague about exactly which open licenses should be used, as they vary greatly in their conditions. Citizens might find it difficult to pick an appropriate license. Some licenses may allow for exploitation of citizen collected data which is contrast with the principles of communing. Additionally, security concerns are sometimes unreasonably used to deny data access requested by citizens.
Local Governments	Encouraging the use of open licenses in data assemblages has several strengths for local governments. When licenses with little to no restrictions on reuse are used, local governments can promote the access, use, and building upon their data by individuals, organisations,	Local governments may face challenges when promoting the use of open licenses for data. Compliance with privacy regulations and legal complexities of different open licenses can be time-consuming and resource intensive. Local governments have limited control over	Local governments can promote a culture of transparency, teamwork, and collective problem-solving among researchers, entrepreneurs, and citizens. This leads to stronger partnerships and collaborations, enhances citizen engagement, and encourages active participation in decision-making processes,	Local governments must be cautious when releasing personal or sensitive data under open licenses to avoid privacy and security risks. To ensure compliance with privacy regulations and safeguard individual rights, they must implement robust data protection measures, legal expertise, and continuous

	Strengths	Weaknesses	Opportunities	Threats
	and communities, fostering a culture of collaboration, knowledge sharing, innovation, and collective intelligence. Making local government data available as open data under open licenses also enables the generation of new insights and research findings, while lowering barriers to entry for start-ups and developers. This, in turn, can facilitate job creation, economic opportunities, and the emergence of new industries. Furthermore, open licensing demonstrates local government's commitment to openness and accountability, encouraging dialogue and engagement with other open data ecosystem	data usage by others. Different open licenses can create confusion, and local governments may need to harmonize licenses to ensure compatibility. This can be challenging for organizations with limited resources or outdated IT infrastructure. Encouraging adoption of open licenses may require education, training, and ongoing communication efforts.	research, and development efforts. They can also attract entrepreneurs, startups, and developers who can utilize open resources to create innovative products, services, and applications. This can lead to economic growth and job creation, as well as the development of new and innovative solutions to civic problems. Furthermore, open licenses ensure compatibility with other systems, reduce duplication of efforts, and optimize resources, improving efficiency and allowing local governments to allocate funds to other critical areas. Lastly, openly licensing data, content, and software code demonstrates a commitment to transparency, enabling citizens to scrutinize and verify the	monitoring. Local governments should also establish processes to ensure data integrity, verification, and maintenance and manage intellectual property rights carefully. Failure to do so could result in legal disputes and infringement claims.

	Strengths	Weaknesses	Opportunities	Threats
	participants, fostering trust, and enhancing transparency in government operations.		information provided. This can foster trust, enhance public perception, and strengthen democratic processes.	
Journalists	No Strengths at the moment.	Without licenses, journalists cannot be sure if they are allowed to use the data, and legal problems and complications may arise. Journalists are aware of the licenses and their importance.	Emerging opportunities for secure and safe use of data can help avoid legal problems if all the datasets have licenses that are understandable by journalists	The restrictions on datasets could only complicate the use of open data and therefore discourage its use. The case of revealing the identity of an individual is only theoretically speculated. In the event that something like that happened, it would be better for the responsibility to lie with the organization that compiled that data instead of adding more restrictions
Students	Open licenses and the culture of communing could facilitate the availability and accessibility to updated, dynamic and timely relevant educational resources.	Regulations on possible data produced by students should be carefully considered according to specific cases. Some data could be sensitive.	Open educational resources are an increasing trend in education which could be expanded by this action principle	Students, teachers, and school administrators lack knowledge on licensing. Empirical data in my research has shown that teachers don't have the awareness to know if an educational resource or data found on the

	Strengths	Weaknesses	Opportunities	Threats
				internet is open or not.
NGOs	NGOs concerned with openness and innovation, such as Open Knowledge Foundation, have historically played part in establishment and promotion of open licenses to the government and private firms. Moreover, many NGOs that use open data in their projects also aim to have open source available as well. Thus, from the NGOs' perspective, that is a relevant action principle that is in line with what they have been pushing for.	From NGOs' perspective, when they interact with public employees as open data providers, the issue with licensing is often related to the lack of knowledge and confusion about legal liabilities. Thus, raising providers' knowledge might need to be at the forefront of the action principle for its successful implementation.	Promoting appropriate legal mechanisms would help NGOs as open data users, as it would make it easier to navigate licensing and data reuse. Moreover, for NGOs promoting open licensing, the action principle would support their organisational goals.	While promoting open licensing is important, it is also good to consider the standardisation of open licenses, as too many options create confusion and lack clarity on their interchangeability. Additionally, as mentioned before, the lack of knowledge on available licensing and its interchangeability creates an additional step to overcome to implement the action principle. However, NGOs may not have the resources to take on the responsibility of raising awareness of other actors.
Companies	Open Licenses encourage reuse for data. Broad licenses are a good fit for reuse by commercial users to make data-enriched services for its clients.	Limitations for commercial use imposed by the data producers.	Open Licenses should include commercial use if commercial users are intended to participate. Licenses should be immediately clear in all published	The use of datasets with no clear license may impose legal risks to commercial users. Big corporations have legal teams to solve these problems, while SMEs may not.

	Strengths	Weaknesses	Opportunities	Threats
			datasets, with no ambiguity.	
Data intermediaries	Open data intermediaries would have to abide to laws and regulations.	Open data intermediaries may find loopholes to circumvent laws and regulations.	Open data intermediaries would have to abide to laws and regulations.	I do not see how open data intermediaries would by themselves adopt open licensing unless it makes sense to their business model or are forced upon them.
Maggioli (partner organisation)	N/A	N/A	N/A	N/A
CoC Playful Minds (partner organisation)	Know-how, practice, and structure that CoC have built over the years.	Regulations tend to be too general and difficult to understand for the organizations. There is no guidance on specific cases. Lack of regulated channels or own channels. All communications among private and public actors are based on social media but there is few knowledge about the appropriateness of using them.	Making differentiation on the types of data. More guidance to know how to safely navigate the regulation.	Dilemmas on protecting data and opening data. The idea of protecting children specially drives the organization to be extra careful on GDPR and other regulations. Regulation cold be highly abstract to understand the limits and opportunities for the organization. Adopting legal mechanisms usually requires a lot of practice and resources.

5. Designing an ecology of interoperable projects

	Strengths	Weaknesses	Opportunities	Threats
Non-specialist data users	Technical interoperability removes certain barriers to citizen participation and is addressed by this action principle.	Interoperability requires significant work to agree on a common set of standards and definitions. The principle is vague about which actors are supposed to undertake this burden. Citizens have limited time, resources, and motivation to dedicate to this issue, especially given that it is hard to make a connection between interoperability and local issues (unless in specific circumstances).	There have been significant EU efforts on achieving data interoperability within and among member states. I cannot identify specific opportunities for citizen participation.	The more the actors involved, the more work is needed to achieve interoperability. Benefits and risks need to be considering when including non-expert (citizen) participants in interoperability objectives.
Local Governments	Interoperability and data portability facilitate collaboration between local governments, government agencies, private sector organizations, and citizens. They allow seamless data exchange, empower citizens to access their own data across different platforms	Interoperability and data portability are crucial in open data ecosystems. It's challenging to align data formats and structures across different systems, particularly for local government organizations with diverse IT	Interoperability standards enable seamless data exchange and collaboration, leading to informed decisions. By integrating data from different systems, local governments can better understand citizen needs and deliver tailored services. Leveraging open	Local governments may face significant challenges in achieving interoperability and data portability in open data ecosystems. Standardizing data may require reconciling variations in data models, definitions, and semantics, which can be time-

	Strengths	Weaknesses	Opportunities	Threats
	and services, and facilitate participation in decision-making processes. To achieve interoperability, local governments must adopt technical standards such as common data formats and APIs. Generative interoperability encourages the development of new tools, services, and applications, fostering economic growth and societal benefits. Local governments can actively advocate for policies that promote interoperability and data portability at regional, national, and international levels. Regulatory measures can align local government policies with broader frameworks, enabling data sharing and collaboration across different jurisdictions.	infrastructures and legacy systems. Multiple actors, including government agencies, private sector organizations, and external partners, must coordinate to implement interoperability and data portability. Local governments must ensure data quality, accuracy, and comply with data protection regulations. Regulatory measures may require changes to existing laws and policies, making it challenging for local governments to navigate legal complexities, so they may need to build internal capacity and raise awareness among staff to achieve interoperability and data portability.	data can attract businesses, entrepreneurs, and investors, leading to job creation and economic development. Finally, exchanging best practices fosters a culture of collaboration and continuous improvement.	consuming and resource-intensive. Balancing the need for data accessibility with privacy safeguards and security measures requires careful planning and robust data governance frameworks. To overcome these challenges, it is essential to establish effective governance structures, data-sharing agreements, and collaboration frameworks. Advocacy and political action are vital in driving policy changes, while training programs and awareness campaigns are critical to ensuring officials understand the benefits and best practices related to interoperability and data portability.
Journalists	No strength at the moment. We are not close to an	Not applicable	I quote, 'This is a journalist's dream.' With an interoperable	No Threats

	Strengths	Weaknesses	Opportunities	Threats
	interoperable ecosystem.		ecosystem, journalists can greatly boost transparency, accountability, and democracy by being able to easily access and combine data from different providers.	
Students	Interoperable objects could support the creation of OD school communities and serve as a base for the development of educational tools.	There are few current examples that can address collection of data and data exploration practices in education. Both activities are highly important for the development of OD competencies in school.	Schools use platforms such as blackboard that are transversal to different educational levels and research institutions. These platforms could create a ground for collaboration and interoperability.	Digital transition in school environment could be very uneven according to different contexts. Some sectors call for making school educational more analog since young people already engage most of their time in digital environments.
NGOs	NGOs would benefit from this action principal implementation, as it would mean fewer costs sustained during the open data reuse, which is often crucial for non-profits. Moreover, some of the NGOs that are active in the open data movement, have advocated for improved interoperability for a long time. Thus, they already	As with licensing, from NGOs' perspective, a lot comes down to data providers having knowledge, skills, and incentives to implement this, which should be taken into account.	Improved standardisation and policies would benefit NGOs as users from reduced open data-related costs to the policies which would promote cooperation. In many instances, it is important for NGOs to cooperate with open data providers and other data users in the ecosystem to fulfil their	It will take resources, advocacy action and political effort that NGOs may not be able to be part of due to resource constraints or lack of a power-holding position in the ecosystem.

	Strengths	Weaknesses	Opportunities	Threats
	implement the action principle.		organisational aims.	
Companies	In my interviews with companies, several mentioned that their services include OD from several sources and that they have dedicated people to integrate these datasets for the service the company offers. More interoperability would help the companies use OD and align their datasets with them.	Interoperability should be done in such a way that non-tech-savvy commercial users can still understand the data. Not all companies, especially SMEs, have a dedicated tech/data department or person.	It can allow for more integration of different data sources, to create better data-enriched services for commercial users. Interoperable standards and vocabularies should be discussed and co-created with commercial users, to adapt to their needs.	The given vocabularies do not adapt to commercial users specific needs, or to each company's given domain(s).
Data intermediaries	Some open data intermediaries have already implemented/been shifting towards interoperability (e.g. open standards) as it makes sense for their business model.	Some open data intermediaries, especially those who are already quite dominant, may be reluctant to adopt interoperable standards.	Some open data intermediaries have already implemented/been shifting towards interoperability (e.g. open standards) as it makes sense for their business model.	Some open data intermediaries, especially those who are already quite dominant, may be reluctant to adopt interoperable standards.
Maggioli (partner organisation)	N/A	N/A	We have 8000 municipalities in Italy. The vast majority of them are very small. 7000 are under 10000 inhabitants. In a very small municipality, you don't have IT people. And also very few people work at all at the municipality. They have a lot of tasks,	N/A

	Strengths	Weaknesses	Opportunities	Threats
			and publishing OD is not their top priority. Less than 10% of Italian municipalities are publishing OD. The % of municipalities with an OD program is very variable depending on the size of the municipality. In bigger municipalities, you would reach around 30-50%, in smaller ones around 5%. Another interesting problem, or limitation, is that even if all these enormous size of municipalities are all managing the same data, there is no standard of contents and naming of the data. This is a big problem from the point of view of a reuser. If I want to find the same data published by different municipalities, I would find thousands of different contents. When I was working in Lombardy Region, we started to define a catalogue	

	Strengths	Weaknesses	Opportunities	Threats
			that could be publish by a municipality, that could be published as a standard. No one has put in place a new version since then. I would like to help you more, but help me to help you. Héctor: What about schema.gov.it? Schema.gov.it is an initial tentative made by the Italian agency for standardization in collaboration with the ISTAT, to compile a catalogue of controlled vocabulary, and ontology. The definition of this standard is still at an early phase. But very few people even know the existence of this site, or have the knowledge to understand it. Very few people and orgs are using this vocab and ontologies. Many times I am discussing with the people inside the project. Even if I understand that ontologies and semantic web are	

	Strengths	Weaknesses	Opportunities	Threats
			very useful inside Linked Data, this is a very complicated matter that requires specific knowledge. Many organizations are just able to publish simple data in a tabular form. When publishing into .csv, this is the most used format used in the world. This is not limiting the creation of a lot of services using this data. The format is not important in my point of view. For some types of data linked data, RDF is a better use, but not for every type of data. Schema.gov.it is a potential standard that can be used, but few people know it or can even use it.	
CoC Playful Minds (partner organisation)	Willingness of the organization to work on it.	Currently, in the CoC network It not possible to exchange data. There are not compatible or interoperable platforms. The organization also lacks technical	From the organization experience, interoperability has become a need.	From the organization experience, interoperability has become a need.

	Strengths	Weaknesses	Opportunities	Threats
		competencies and software.		

6. Ensuring sustainability of OD Ecosystems

	Strengths	Weaknesses	Opportunities	Threats
Non-specialist data users	The action principle reflects the need for alternative business models which can benefit citizen participation (crowdfunding, and others).	Alternative business models may place additional burdens on citizens. Crowdfunding campaigns and other initiatives based on data commons are time-consuming and may place additional burdens when compared to existing business models. The action principle should take this risk into account.	Crowdfunding and other new business models may open up needed resources for citizen participation and local actors who are motivated to contribute, but who lack the resources to do so.	Certain business models are prone to exploitation by private actors. Looking of Open Source Software, for example, certain private actors can fund open source software to steer it in a desired direction, ultimately alienating the community.
Local Governments	Open data ecosystems provide valuable information for developing innovative products, services and solutions, which can significantly enhance economic growth. Additionally, they help reduce costs and facilitate efficient decision-making processes, which results in more effective and	Advocating for public funds to support open data initiatives is challenging. Local governments must demonstrate the economic benefits and develop sustainable business models. They can learn from successful examples and	Local governments can partner with each other to create and manage open data projects, leading to shared investments, revenue-sharing agreements, and benefits for all. By participating in local, national, and global open data ecosystems, local governments can gain valuable insights, learn	Local governments often have limited resources, which can make it challenging for them to allocate funds and personnel to support open data initiatives. Effective collaborations and partnerships with other groups are crucial for economic sustainability.

	Strengths	Weaknesses	Opportunities	Threats
	responsive public policies and services. Open data ecosystems also enable local governments to establish trust with citizens, increase public participation, and optimize resource allocation, ultimately leading to higher quality public services.	explore revenue streams, such as data licensing and partnerships. It is essential to consider cultural differences and community needs to adapt them. Additionally, local governments should involve diverse groups, ensure equitable access, and promote responsible data management practices. Ecosystem mapping can help address social and environmental challenges.	from successful practices, and adapt them to their own context. They can also monetize their open data assets by developing data licensing models, generating revenue streams that support the sustainability of the open data ecosystem and drive economic activity. Moreover, open data can promote environmental sustainability efforts by providing information for evidence-based decision-making and encouraging sustainable practices. Local governments can leverage open data to monitor and manage environmental resources, facilitate sustainable urban planning, and engage citizens in environmental initiatives. Ecosystem mapping approaches can help identify areas where open data can contribute to	However, maintaining these relationships can be difficult due to differing priorities and organizational cultures. Local governments may also face difficulties in ensuring the accuracy, completeness, and timeliness of their data and developing and maintaining the technical infrastructure required for open data initiatives. A lack of awareness and understanding of the potential economic benefits of open data, a lack of in-house expertise and data protection regulations can all hinder the adoption and implementation of open data practices.

	Strengths	Weaknesses	Opportunities	Threats
			environmental sustainability goals locally.	
Journalists	No Strengths at the moment	At the moment, there are no sustainable business models for the use of open data in the media. All the projects that are outside of very big media organizations are funded by donations, the EU, or other institutions. People are aware of open data, how they can use it, and how they can benefit from it.	With mapping of the open data ecosystem, journalists will be able to identify and find people to work with and collaborate with. There may be sustainable business models, but we have to discover them.	The threat is for things to stay as they are.
Students	The inclusion of students and enhancing their role as active citizens in their local communities could be seen as signs of social sustainability. Furthermore, students using OD to better understand their environment and solve environmental problems could lead or drive environmentally sustainable practices.	School education is highly dependent of national or regional regulations and funding. Sustainability of OD initiatives in education should be integrated in educational systems and curriculum designs. In this way, assuring their permanence in curriculum and	Cooperation between private and public sectors could lead the development of tools and models than otherwise are difficult to achieve. On the other side, public initiatives with influence in education can also support schools and teachers in creating capacity and developing abilities for data-driven and digital education.	Infrastructure for OD in education is currently inexistent. The challenge is not just sustained it over time but create it.

	Strengths	Weaknesses	Opportunities	Threats
		learning designs.		
NGOs	The economic funding aspect is important for the sustainability of NGOs and, if implemented, could support them to stay on as part of the ecosystem and bring value back to it for longer and more efficiently. Moreover, social and environmentally sustainable practices are important considerations for many NGOs, so the action principle can help them with their implementation or can include already existing practices.	If public funding in question comes not solely from individual donations but through government grants, it can create a certain bias towards specific projects and value that NGOs deliver. Thus, there should be a consideration of how financial support might affect the kind of value that gets back into the ecosystem, and who is benefiting from it. However, individual donations and crowdfunding are often not enough to support NGOs in the long run.	The action principle can give an opportunity to NGOs to be financially supported and share their existing environmentally sustainable practices during the ecosystem mapping.	As mentioned earlier, sustainable funding should be carefully approached in the context of NGOs and the possible biases it can cause.
Companies	Ecosystem mapping is critical to knowing where funds should be directed.	How to keep economic sustainability of the OD Ecosystem, while maintaining the economic sustainability of its commercial stakeholders.	N/A	N/A

	Strengths	Weaknesses	Opportunities	Threats
Data intermediaries	N/A	N/A	N/A	N/A
Maggioli (partner organisation)	N/A	N/A	In the case of Italy, because of the number of small municipalities, having an automated and easy way of publishing data is the best way to keep the sustainability of the ecosystem.	N/A
CoC Playful Minds (partner organisation)	Social sustainability. CoC is focused in creating a local network that works why itself even if the organization is not present. Their projects are aimed at building competencies for the future, for empowerment and for building sustainable communities.	Definition of the business model. It has been in discussion for the past 8 months.	Sustainability is part of all project planning and strategy as a company. Creating value	Economical perspective. Funding for projects could make difficult assure the purpose of the organization and missing the perspective of children.