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Developing an Open Data Intermediation Business Model: Insights From the Case of Esri

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ABSTRACT

Despite the many promises of open data, numerous challenges inhibit its full potential, such as its poor or inconsistent quality, a lack of complementary assets, and the limited skills of data providers and end-users. Open data intermediaries are instrumental in addressing some of these challenges. They provide specialized resources and capabilities to enhance the supply, flow, or use of open data, or strengthen the relationships among various open data ecosystem (ODE) actors. However, in-depth studies on open data intermediation business models are limited, with most having only offered birds-eye views of those business models. This deficiency has limited our knowledge to develop open data intermediation business models that contribute positively to the ODE. In the geospatial domain, Esri is an important open data intermediary, having been involved in such a role since the 1990s. This article unpacks Esri's open data intermediation business model and analyses its current strengths and weaknesses as well as its potential opportunities and threats to the ODE. Finally, this article recommends factors to consider in developing an open data intermediation business model that supports the sustainability of the ODE.

1 | Introduction

Open data, defined as 'data that can be freely used, modified, and shared by anyone for any purpose' (OKF 2013), promises various benefits, including stimulating innovation, improving disaster responses, addressing public health crises, facilitating sustainable urban planning, and catalyzing citizen engagement (Adaktylou, Stratoulias, and Landenberger 2020; Biljecki et al. 2021; Brovelli and Coetzee 2021; Degbelo 2022; Mooney et al. 2021; Zhu et al. 2019). In May 2013, United States (US) President Obama signed an executive order asserting open and machine-readable data as the new default for government information to boost economic growth and promote efficient and effective public services, among other reasons (Obama 2013). In the following month, the Group of Eight (G8) governments signed the G8 Open Data Charter to 'develop new insights and innovations that can improve the lives of others' (G8 2013). The European Union (EU) enacted the Re-use of Public Sector Information Directive in 2003 (Directive 2003/98/EC of the European Parliament and of the Council of 17 November 2003 on the Re-Use of Public Sector Information 2003), which was then recast as the Open Data Directive in 2019 to 'promote the use of open data and stimulate innovation in products and services' (Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on Open Data and the Re-Use of Public Sector Information, EP, CONSIL, 172 OJ L 2019).

The value of open data has long been recognized in the geospatial domain (Greene and Rinner 2022; Onsrud 1992; Wulder et al. 2012). Three decades ago, McLaughlin & Nichols (1994,

67) wrote that 'If goals such as sustainable development are to be reached, then private individuals, citizen groups, and all levels of public and private sector organisations require timely access to a wide variety of databases and [...] the capability of integrating that data horizontally [i.e., across types] and vertically [i.e., across administrative boundaries]'. As Gray (2014) pointed out in his work on the genealogy of open data, the geospatial domain had dealt with various issues and controversies related to open data years before they were encountered in other domains. More recently, the EU Open Data Directive lists specific high-value datasets across six thematic categories, four of which constitute (geo)spatial datasets (geospatial, earth observation and environment, meteorological, and mobility) (Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on Open Data and the Re-Use of Public Sector Information, EP, CONSIL, 172 OJ L 2019), thereby affirming the importance of such data.

Despite its many promises, numerous challenges inhibit the full potential of open data, such as its poor or inconsistent quality, a lack of complementary assets, and the skill limitations of data providers and end-users (Benitez-Paez, Degbelo, et al. 2018; Johnson et al. 2017; Nikiforova and Zuiderwijk 2022; Temiz et al. 2022). The concept of an open data ecosystem (ODE) has been promoted as a lens through which to study and devise interventions so as to optimize the potential value of open data (Davies 2011; Najafabadi and Luna-Reyes 2017; Pollock 2011). In an ODE, actors are understood as autonomous and self-interested, yet interdependent entities (Poikola, Kola, and Hintikka 2011), and their relationships are thus self-organized (Davies 2011). van Loenen et al. (2021) argued that a sustainable (i.e., enduring or long-lasting) and value-creating ODE is characterized as being user-driven (open data supply matches the demands of users of different types and domains), circular (all actors mutually create and capture value), inclusive (all actors, not only governments, are incentivized to contribute open data and participate in ecosystem processes), and skill-based (appropriate data skills and competencies are applied).

Various expectations for open data to be 'actionable data' (Gutierrez and Landa 2021) cannot be fulfilled by open data providers or end-users alone. Open data intermediaries serve a central role in the efficient circulation of resources and, consequently, in addressing various challenges in the ODE (Chattapadhyay 2014; van Schalkwyk, Willmers, and McNaughton 2016; World Wide Web Foundation 2015). Open data intermediaries have been defined theoretically as 'third-party actors who provide specialised resources and capabilities to (i) enhance the supply, flow, and/or use of open data and/or (ii) strengthen the relationships among various open data stakeholders' (Shaharudin, van Loenen, and Janssen 2023, 1). They are neither the original open data providers nor the end-users. An open data intermediary can also perform activities unrelated to open data; that is, intermediating open data is not necessarily its sole function (Shaharudin, van Loenen, and Janssen 2023). Examples of open data intermediaries include software providers that process and integrate open data in their software (e.g., Citymapper and Esri), crowdsourcing platforms that compile and facilitate the reuse of open data from various contributors (e.g., OpenStreetMap and Wikidata) and portals integrating data from different open data sources (e.g., Global Forest Watch and Humanitarian Data Exchange).

Despite the importance of open data intermediaries having been widely acknowledged in research and practice (Carolan 2016; Davies and Perini 2016; Dove et al. 2023; Publications Office of the European Union 2023), studies on open data intermediation business models are limited in number and scope (Germano, de Souza, and Sun 2016; Janssen and Zuiderwijk 2014; Magalhaes, Roseira, and Manley 2014; Magalhaes and Roseira 2020). This poses a problem since business model design and innovation are often associated with organizations' performance and longevity (DaSilva and Trkman 2014; Kesting and Günzel-Jensen 2015; Peric, Durkin, and Vitezic 2017). Besides, business models also clarify the relationships between an organization and other stakeholders (Lambert and Davidson 2013). It is crucial to understand how open data intermediation business models affect other ODE actors and be developed to support the sustainability of the ODE based on features suggested by van Loenen et al. (2021).

Therefore, this article aims to address the knowledge gap by asking: what factors should be considered in developing an open data intermediation business model that contributes to the sustainability of the ODE? Towards that end, we chose to investigate the case of Esri. The company has been involved in (open) data intermediation since the 1990s, and its software package, ArcGIS, leads the global market share of geographic information system (GIS) software. Hence, Esri stands to offer illuminating insights for answering our research question.

To answer the stated research question, this article tackles three research objectives: (1) to detail Esri's open data intermediation business model, (2) to consider the current strengths and weaknesses, and potential opportunities and threats, of Esri's open data intermediation business model to the ODE, and (3) to formulate factors to consider in developing an open data intermediation business model that can contribute to the sustainability of the ODE.

The remainder of this article is organized as follows. Section 2 delves into the concept of (sustainable) ODEs, the role of open data intermediaries, and a selection of relevant organizational and management theories that provide vantage points into Esri's business model and its implications to other ODE actors. Section 3 presents the methodology of this paper. Section 4 briefly describes Esri and the evolution of its (open) data intermediation. Section 5 presents Esri's open data intermediation business model (Objective 1). Section 6 presents the analysis of the strengths, weaknesses, opportunities, and threats of Esri's open data intermediation business model to the ODE (Objective 2). Section 7 formulates the factors to consider in developing an open data intermediation business model that supports the sustainability of the ODE (Objective 3). Finally, Section 8 concludes the article.

2 | Conceptual Framework

2.1 | (Sustainable) ODE

In theory, open data allows data to flow across organizations more easily than non-open data, as it is shared free of charge in a machine-processable format under an open license (International Open Data Charter 2015). However, generating value from open data is not without hurdles (Coetzee et al. 2020;

Johnson et al. 2017; Johnson and Varga 2022). Processing open data may involve laborious work, especially if the data come from multiple sources with different models and formats (Aydinoglu and Bilgin 2015). It may also involve technical skills and complementary assets that are not at the disposal of end-users (Okamoto 2016; Temiz et al. 2022). End-users may also have to deal with poor or inconsistent open data quality (Benitez-Paez, Degbelo, et al. 2018; Quarati, De Martino, and Rosim 2021; Welle Donker and van Loenen 2017).

Davies (2011) argued that successful value generation from open data relies on the 'mobilisation of a wide range of technical, social and political resources, and on interventions [...] to support coordination of activity around datasets' (Davies 2011, 1). He thus advocated the concept of ODE, wherein 'the emergent, autonomous, and self-organising components' are 'linked together in local and global feedback loops and developing according to local specialisations and adaptation rather than top-down design' (Davies 2011, 3). Csáki (2019) defined an ODE as a 'way of looking at how participating actors and groups create shared meaning and generate value around open data and how the structural properties of their interactions shape this process, which in turn enables or constrains the growth and health of the ecosystem itself' (Csáki 2019, 19).

Oliveira and Lóscio (2018) identified four conceptual elements of an ecosystem, namely resources (datasets, data-based software, and hardware, which may be exchanged, individually or in combination, through relationship transactions), roles (the functions of actors within the ecosystem), actors (autonomous entities such as companies, public organizations, and individuals serving one or more specific roles), and relationships (interactions among actors in the ecosystem). This conceptualisation underscores that actors are not wedded to any specific roles. For example, government organizations can play other roles besides publishing open data (Shaharudin, van Loenen, and Janssen 2024; Sieber and Johnson 2015).

Actors in the ODE are considered self-interested and autonomous yet interdependent with each other (Poikola, Kola, and Hintikka 2011). Consequently, to optimize the value of open data, strategies should focus on community building instead of top-down interventions (Benitez-Paez, Comber, et al. 2018; Davies 2011). Within the field of geospatial data, the shortcoming of the top-down model of data strategies (albeit not limited to open data) was acknowledged by the US National Research Council as early as 1993. Indeed, in its report, it is stated that 'the old "top down" model [...] is inadequate to represent the multidirectional alternative information flows that are now technically feasible' (National Research Council 1993, 8).

According to van Loenen et al. (2021), sustainable value-creation and maintenance of the ODE depend on it being user-driven, circular, inclusive, and skills-based. The features they prescribed are comparable (but more precise) to those formulated by Heimstädt, Saunderson, and Heath (2014), who drew inspiration from business ecosystems. These features are not mutually exclusive. In this article, we thus rely on the normative framework of a sustainable ODE by van Loenen et al. (2021), since it provides a concise frame of reference with which to work.

2.2 | Open Data Intermediaries

We follow the theoretical definition of open data intermediaries by Shaharudin et al. (2023, 1): 'third-party actors who provide specialised resources and capabilities to (i) enhance the supply, flow, and/or use of open data and/or (ii) strengthen the relationships among various open data stakeholders'. The role of open data intermediaries in enhancing the access to and use of open data (Chan, Johnson, and Shookner 2016; González-Zapata and Heeks 2015; Neves, de Castro Neto, and Aparicio 2020) and connecting ODE actors (Mayer-Schönberger and Zappia 2011; Yoon, Copeland, and McNally 2018) is critical. Since the ODE implies the self-organization of actors (Davies 2011; Oliveira and Lóscio 2018), open data intermediaries are also crucial in mitigating information asymmetry between actors.

Open data intermediaries exist in diverse shapes and forms, employing diverse business models. It is important to note that open data intermediation products or services are not necessarily provided for free, despite being based on open data (van Schalkwyk et al. 2016), depending on the business model adopted. Various types of actors can perform open data intermediation, including public agencies such as the Atlas of Living Australia (Belbin and Williams 2016), for-profit companies such as Citymapper (Tavmen 2024) and non-profit organizations such as Missing Maps (Meijer and Potjer 2018).

Open data intermediaries should not be confused with the 'data intermediaries' defined in the EU Data Governance Act (DGA) framework (Regulation (EU) 2022/868 of the European Parliament and of the Council of 30 May 2022 on European Data Governance and Amending Regulation (EU) 2018/1724 (Data Governance Act), 152 OJ L 2022). As explicitly written in the Act, it does not apply to open data, which is governed by the Open Data Directive (see, e.g., item 10 of the preamble). Furthermore, data intermediaries of the DGA are prohibited from using the data they intermediate (e.g., to develop products) and are limited to enabling data sharing between parties. In contrast, open data intermediaries can use open data themselves, including for financial gain, since the data is already open data.

2.3 | Business Model and Related Concepts

There are multiple interpretations of the 'business model' (Afuah 2018; Timmers 1998; Voigt, Buliga, and Michl 2017). Generally speaking, a business model contains at least three dimensions: value proposition (benefits to customers), value creation (ways to deliver the value proposition), and value capture (benefits to the organization) (Afuah 2018; Voigt, Buliga, and Michl 2017). In other words, a business model is a framework for comprehending what an organization offers to customers (the what), how they do so (the how), and why they provide such offerings (the why). As Spencer (2013) highlighted, a business model is not only a pricing mechanism or a logistics chain but rather the entire system of resources and processes involved in offering, creating, and capturing value. Turning to our research context, the open data intermediation business model does not necessarily imply that an organization's sole function is to

intermediate open data. Instead, it refers to an organization's what, how, and why aspects directly or indirectly related to open data intermediation.

Open data intermediation business models exist in various shapes and forms (Janssen and Zuiderwijk 2014; Magalhaes and Roseira 2020). Esri's open data intermediation business model can be considered as representing what we call the one-stop package archetype. This archetype is described as offering multiple product/service units around a (restricted) data platform/repository based on (augmented) open data. Augmented open data refers to open data that is enhanced by combining it with non-open data. Revenue for this archetype is generated through subscription fees or software sales. Other examples of this archetype are CARTO, Nasdaq Data Link, and Enigma.

Several strategic management and organizational theories and frameworks may offer guidance or explanations for business model design and innovation. One is the resource-based view (RBV) (DaSilva and Trkman 2014; Hedman and Kalling 2003), which postulates that organizations can maintain a sustained competitive advantage by leveraging their valuable, rare, imperfectly imitable, and non-substitutable (VRIN) resources (Barney 1991). Resources can take the form of an organization's assets, capabilities, organizational attributes, brand, and knowledge, among other examples (Barney 1991). Information technology (IT) capabilities, including IT infrastructure and skills, can also be VRIN resources (Seddon 2014). The literature on RBV has also expanded to consider inter-organizational networks, partnerships, and social capital as a type of VRIN resource (Eisenhardt and Schoonhoven 1996; Gulati, Nohria, and Zaheer 2000; Lavie 2006; Yi, Chen, and Li 2022).

Another relevant concept related to the business model is that of the value driver (Amit and Zott 2001; Leppänen, George, and Alexy 2023; Spieth et al. 2019; Visnjic et al. 2017). Value drivers are broad dimensions of attributes leveraged to attract and retain customers. Amit and Zott (2001) identified four value drivers, namely novelty (e.g., new content, new structures, and new participants), lock-in (high switching costs and positive network externalities), complementarity (e.g., between products and services, between technologies, and between activities), and efficiency (e.g., low transaction costs, simplicity, speed). These value drivers are not mutually exclusive. Visnjic et al. (2017) proposed the fifth value driver, accountability, where an organization can help manage or eliminate risks and internalize 'unmanageable' risks of its customers.

Organizational identity theory may also explain or guide business model design and innovation (Bojovic, Sabatier, and Coblence 2020; Kohtamäki et al. 2019; Snihur 2016). The theory suggests that organizational identity (i.e., 'who we are as an organisation') informs strategic and organizational decisions (Gioia et al. 2013; Kohtamäki et al. 2019), including the business model. An organizational identity consists of three characteristics: central (some features are believed to be fundamentally core to the organizational identity, and are thus deliberately preserved), enduring or continuous (the identity is deemed stable over time, not necessarily from the eyes' of outsiders but from the perspective of the members), and distinctive (where the organization sees itself simultaneously similar to some desirable referent group, such as an industry, but also notably different from members of the group) (Albert and Whetten 2003; Gioia et al. 2013; Whetten 2006). Organizations involved in IT businesses are particularly confronted with the need to maintain their well-established identity on the one hand and adapt to the rapidly changing environment on the other (Wang, Huang, and Tan 2013).

3 | Research Methodology

This article employs the single-case study methodology (Yin 2018). Case studies are used to derive new insights into topics for which existing studies and evidence are scarce (Gerring 2006), as in the topic of the open data intermediation business model. A single-case study, in particular, is deemed appropriate when the case is remarkably revelatory or exemplar (Eisenhardt and Graebner 2007; Siggelkow 2007; Yin 2018), which could well be said of Esri's open data intermediation business model. Esri is a market leader in GIS and has long been an open data intermediary. A single-case study allows for a deep contextualized understanding of the case in question through 'thick' descriptions, that may be difficult to achieve through a multiple-case study (Dyer and Wilkins 1991; Siggelkow 2007). The highly elaborate ways in which Esri offers, creates, and captures value from or with open data, as well as the prevalence of Esri products in the geospatial domain, warrant its investigation through a single-case study.

Esri distributes its software outside of the US through local companies called distributors. While Esri Inc. (its parent company in the US) devises the overarching global mission regarding open data for the multinational entity, each distributor devises and implements its specific local strategies. Hence, to more fully understand how Esri plays a role as an open data intermediary, we gathered data not only from Esri Inc., but also from five of its distributors, namely Esri Germany, Esri Netherlands, Esri Spain, Esri United Kingdom (UK), and Geoinfo Denmark (Esri's distributor in Denmark). We selected these five distributors because they operate in countries with a considerable level of open geospatial data, driven by both the European Union (EU) Directive on the Re-use of Public Sector Information (Directive 2003/98/EC of the European Parliament and of the Council of 17 November 2003 on the Re-Use of Public Sector Information 2003) that came into force in 2003 (recast in 2019) and the EU Directive for Infrastructure for Spatial Information in the European Community (INSPIRE) (Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 Establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) 2007) that came into force in 2007 (Haarsma 2012; Minghini et al. 2021; van Loenen and Grothe 2014).

We gathered data from 27 interviews involving 29 participants and publicly accessible sources, such as materials on websites (including archival materials via Wayback Machine), videos, and audio podcasts (cited accordingly). We interviewed a top-level senior executive from Esri Inc. as well as representatives from the above-listed five distributors. Moreover, we interviewed

representatives from eight geospatial data providers (including key persons from national mapping agencies, a city council, and OpenStreetMap (OSM) Foundation), ten Esri products users (from research institutions and the industry), a key person from a national geospatial data coordination organization, and a key person from the Open Source Geospatial Foundation (OSGeo). OSM is an open geodatabase project updated and maintained by a community of volunteers, and the OSM Foundation is a not-for-profit organization that supports the OSM project (OSM Foundation 2024). OSGeo is a not-for-profit organization that fosters the adoption of open source geospatial software (OSGeo 2024). The de-identified interview transcripts are available at https://doi.org/10.4121/f86d0e4c-851f-4378-a1bc-41210235ad61.

Table 1 presents the identification (ID) of the interviewees to facilitate the presentation of the findings. We omitted the names of the interviewees' organizations and countries to avoid the re-identification of the interviewees, since the geospatial data community in some countries is close-knit. Throughout the article, depending on circumstances (e.g., for brevity or whether the statements cited may be deemed controversial), we either use the name of the organization or the ID of the interviewees but never both at the same time.

We analyzed the data based on the abductive approach (Dubois and Gadde 2002), which seeks to overcome the disengagement between theory and reality through systematic combining, that is, going back and forth between the theories, data, and analysis. Open data intermediation business model exists and can be designed in various shapes and forms, and Esri's business model represents only a specific archetype. Hence, not all insights from the Esri case may be directly transferable to all archetypes of open data intermediation business models, but they may still set the groundwork for theorizing other archetypes.

4 | Case Background: Esri and Its Evolution as an (Open) Data Intermediary

4.1 | Esri: The Company's Background

Esri is a multinational GIS software company headquartered in Redlands, California. It is a global market leader in GIS, with its software suite, ArcGIS, used by over 350,000 organizations, including 90% of Fortune 100 companies, over two-thirds of Fortune 500 companies, many national governments, approximately 30,000 cities and local governments, and roughly 12,000 nonprofit organizations (Esri n.d.-a). The software is used in over 60 industries, including banking, retail, transportation, utilities, government, and health and human services (Geospatial Media and Communications 2018). Esri has an annual revenue of over $1.3 billion (Hoffman 2021). In 2018, Forbes valued the company at $5.5 billion (Daniel 2018).

The company was founded in 1969, making it one of the oldest software companies, older even than SAP (1972), Microsoft (1975), Apple (1976), and Oracle (1977). It was founded as Environmental Systems Research Institute Inc. (ESRI) by Jack Dangermond, a landscape architect, and his wife, Laura Dangermond, a social scientist. They both worked at the Harvard Laboratory of Computer Graphics and Spatial Analysis, where the early development of computer map-making took place. Before commercializing its GIS software, the company started as a consulting firm helping land use planners and resource managers make informed decisions based on computer mapping and spatial analysis. Unlike most software companies, Esri has always been privately held—without outside investors, liquidity events, or stock options (Esri n.d.-a; Hoffman 2021).

Esri distributes its software outside the US through locally owned companies called distributors. They have exclusive rights to distribute ArcGIS in their countries. They have been either independent from Esri Inc. from the start or Esri Inc. made a small investment in them (Hoffman 2021). Besides reselling ArcGIS, Esri distributors support local customers by addressing their specific queries and needs as well as by facilitating the broad local development of GIS in the country. Esri Inc. and its distributors, while operating individually, often collaborate and exchange ideas about marketing, business development, and technology support (Hoffman 2021).

ArcGIS products run on desktops, mobile devices, and the cloud (Esri n.d.-e). ArcGIS Pro, ArcGIS Online, and ArcGIS Enterprise are some of the company's most popular products. ArcGIS Pro is a desktop GIS application that supports data visualization, advanced analysis, and authoritative data maintenance in 2D, 3D, and 4D. ArcGIS Online is a cloud-based software for creating and sharing interactive web maps. ArcGIS Enterprise is a complete mapping and data management server software used to create maps, analyze, and share data. It can be deployed on-premises or in the cloud.

4.2 | The Evolution of Esri's (Open) Data Intermediation

We have placed the term ‘open’ in parentheses because, before 2010, the term ‘open data’ (or even the term ‘open access’, which was more common then) was not apparent in the descriptions of any Esri's data-related services. Although the company had been facilitating the access and reuse of free-of-charge data since the late 1990s, the legal rights of the data were not clearly defined (at least, based on the archival materials we could access). Only in 2010 did the Community Maps Program state that organizations seeking to contribute data through the programme must provide ‘royalty-free redistribution’ data at no cost (Esri 2010a), which reflects the concept of open data (despite the term itself having not been explicitly used). Besides, Esri also intermediates non-open data through its services, although such activities are not the focus of this article.

Esri has long recognized that data is at the heart of GIS application and innovation and, thus, crucial for its products' continuous growth and relevance (Esri Events 2016). Figure 1 shows the archived webpage of Esri captured in November 1996 that reads, ‘Just as a car won't run without gasoline, a GIS without data has no information’ (Esri 1996). In the early 1990s, when geospatial data was shared as files on CDs and other media, such as FTP (file transfer protocol), Esri offered best practices and data models for efficient data sharing (Esri Events 2016). Later, in 1996, only a few years after the

TABLE 1 | Identification of interviewees.

Interviewee ID	Organization	Country	Role
01-Esri-A	Esri distributor	A	Consultant
02-Esri-B	Esri distributor	B	Content manager
03-Esri-C	Esri distributor	C	Content manager
04-Esri-C	Esri distributor	C	Content manager
05-Esri-D	Esri distributor	D	Content manager
06-Esri-D	Esri distributor	D	Content manager
07-Esri-E	Esri distributor	E	Content manager
08-Esri-E	Esri distributor	E	Marketing manager
09-Esri-O	Esri Inc.	N/R	C-level executive
10-StO-C	National geospatial data coordination organization	C	Manager
11-Prov-B	Data provider (municipal)	B	Geospatial data manager
12-Prov-E	Data provider (national)	E	Geospatial data consultant
13-Prov-E	Data provider (national)	E	Geospatial data manager
14-Prov-D	Data provider (national)	D	Geospatial data manager
15-Prov-D	Data provider (national)	D	Geospatial data manager
16-Prov-C	Data provider (national)	C	Geospatial data manager
17-Prov-B	Data provider (national)	B	Geospatial data manager
18-Prov-O	OSM Foundation	N/R	Board member
19-OSG-O	OSGeo	N/R	Chair of a local chapter
20-User-E	Research institution	E	Esri user
21-User-E	Company	E	Esri user
22-User-A	Research institution	A	Esri user
23-User-D	Research institution	D	Esri user
24-User-C	Company	C	Esri user
25-User-C	Company	C	Esri user
26-User-C	Research institution	C	Esri user
27-User-D	Research institution	D	Esri user
28-User-C	Research institution	C	Esri user
29-User-C	Research institution	C	Esri user

Note: N/R means not relevant, as these interviewees represented a more global perspective.

launch of the World Wide Web, Esri introduced the ArcData Publishing Program, where users could download hundreds of ready-to-use datasets from Esri and other companies, some free of charge (Esri 1996) (Figure 1). Esri also introduced Data Hound in 1998, a search engine that brought users to external websites offering freely downloadable data compatible with Esri software (Esri 1998) (Figure 2).

In June 2000, Esri introduced Geography Network (Figure 3), a website from which to access, share, and download geographic content from around the world. While most of the content was freely downloadable or at least viewable, some were commercial. Whenever a commercial map was viewed or a commercial dataset downloaded, a charge was recorded in the Geography Network e-commerce system, and Esri would bill users and pay content providers (Dempsey 2000; Esri 2000). The Geography Network was an enhanced consolidation of Esri's previous data-related services (ArcData and Data Hound). Data Hound was discontinued by 2001 and ArcData by 2003 (Esri 2001, 2003). Additional offerings of the Geography Network included the Live Map Services, where several map services[1] were available on a subscription basis, and the Map Exchange, where users could share static map images on the website (Geography Network 2000). The Geography Network was retired in December 2009 as the services it provided were then incorporated into a web-based ArcGIS Online software package launched in the same year (Geography Network 2009).

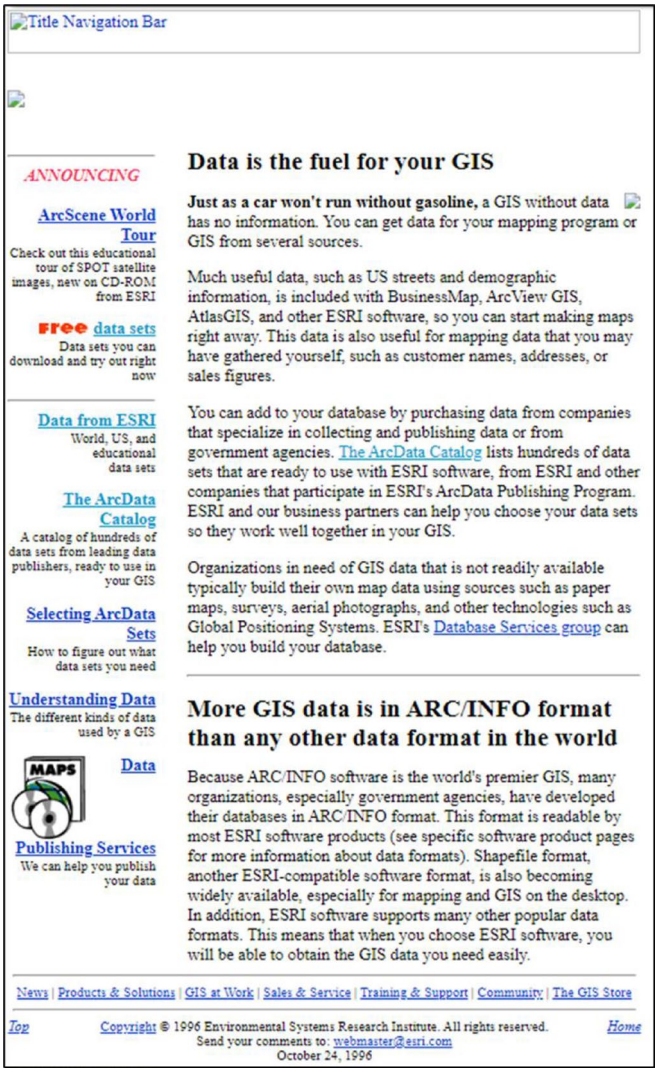

FIGURE 1 | Archived webpage of Esri (captured on 4 November 1996). *Source:* Esri (1996) from Wayback Machine by Internet Archive.

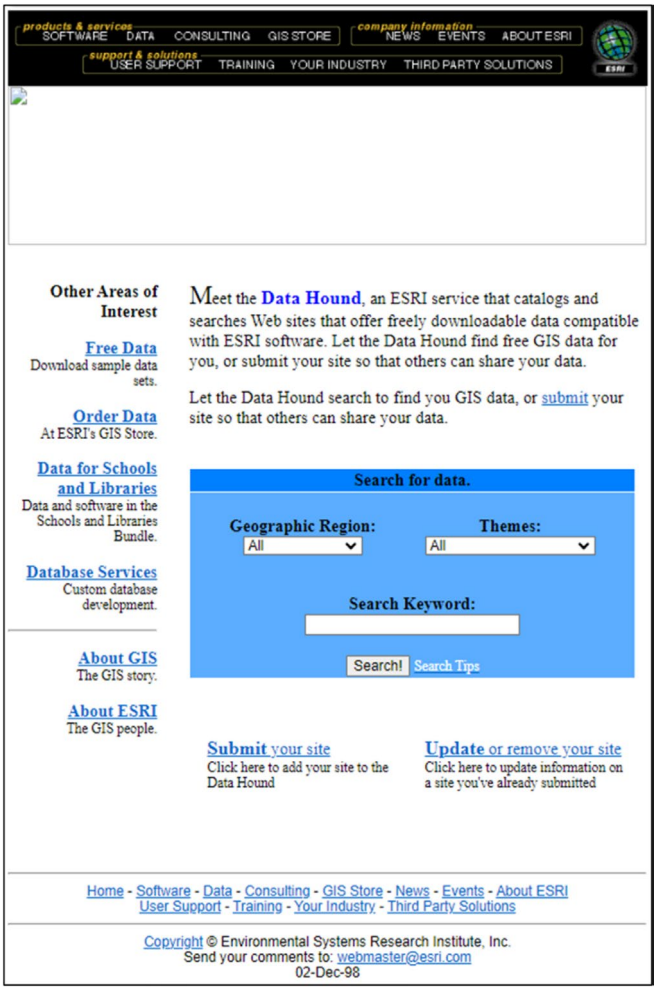

FIGURE 2 | Archived webpage of Esri's Data Hound (captured on 3 December 1998). *Source:* Esri (1998) from Wayback Machine by Internet Archive.

In 2010, Esri introduced the Community Maps Program (Esri 2010a), where ArcGIS organizational users can share their local data to improve the suite of basemaps[2] created and hosted by Esri. Since then, the company has accepted, processed, and published hundreds of millions of vector data (e.g., roads, buildings, addresses) and tens of millions of square kilometers of raster data (e.g., imagery, digital elevation models) (Esri n.d.-d; Kensok 2020b). The basemaps also include OSM data (Kensok 2020a).

In 2014, just about a year after President Obama signed an executive order to make open data the new default for government information (Obama 2013), Esri introduced ArcGIS Open Data as part of ArcGIS Online, to make it easier for data providers to publish open data (Claessens 2016; Esri n.d.-c). ArcGIS Open Data was later rebranded as ArcGIS Hub. Also in 2014, Esri launched Living Atlas of the World (Berry 2024; Esri n.d.-b), in which Esri Inc. and its distributors actively curate geospatial information (maps, apps, data layers) and imagery (e.g., on demographics, landscape, and transportation), beyond basemaps (Esri 2014).

In February 2023, Esri joined the Overture Maps Foundation, a collaboration founded by Amazon Web Services (AWS), Meta, Microsoft, and TomTom. Overture aims to create reliable, easy-to-use, and interoperable open global map data. Overture compiles and enhances OSM data with other sources to produce new open map datasets to be used by mapping platforms and service developers (Overture Maps Foundation 2023), including Esri customers (interviewee 09-Esri-O). Esri contributes to Overture in three ways: by sharing data gathered through its Community Maps program, contributing human resources to help define data schemas and build certain information products and providing infrastructure support (09-Esri-O). In sum, Table 2 presents the evolution of Esri's (open) data intermediation over the years.

5 | Esri's Open Data Intermediation Business Model

5.1 | The What: Esri's Open Data Intermediation Value Propositions

Generally speaking, there are four value propositions of Esri's open data intermediation. *First*, Esri provides a software system that is in itself an (open) geospatial data platform (01-Esri-A, 03-Esri-C, 09-Esri-O, 25-User-C, 26-User-C). ArcGIS software

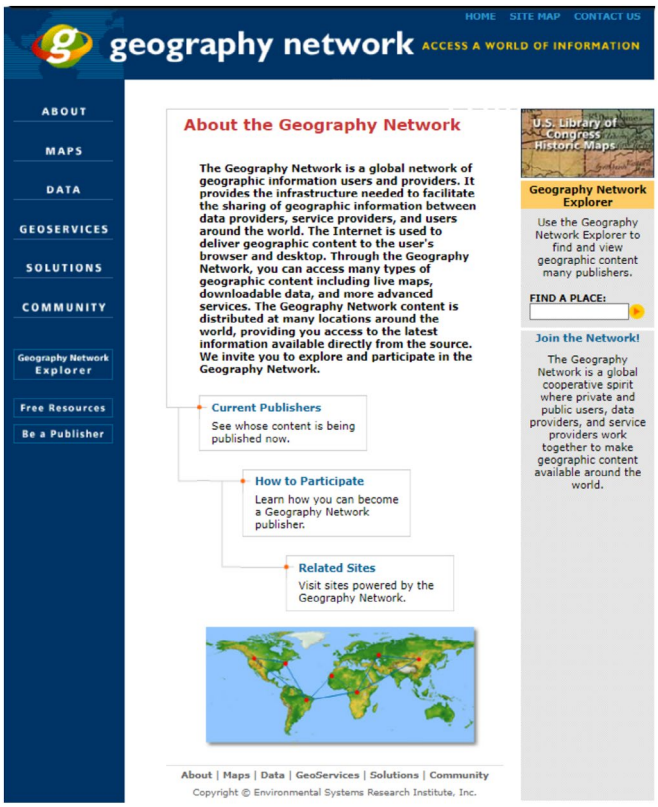

FIGURE 3 | Archived webpage of Geography Network (captured on 16 August 2000). *Source:* Geography Network (2000) from Wayback Machine by Internet Archive.

comes with a suite of basemaps that users can use immediately, which Esri enhanced through its Community Maps programme. Moreover, ArcGIS users can reuse millions of other objects (e.g., data files, layers, maps, apps, and services) provided by other ArcGIS users, hosted in ArcGIS Online (Esri 2023b). A subset of these are those curated by Esri Inc. and its distributors as part of the Living Atlas. Some of the objects in the Living Atlas are also reusable by non-ArcGIS users. Conversely, ArcGIS users can contribute their data in the ArcGIS system how they prefer, including by deciding the type of license they would like to affix to their data, including an open license (e.g., Creative Commons, Open Database License, and Public Domain). Nevertheless, ArcGIS users can change their data sharing decisions, making ArcGIS software unsuitable for guaranteeing data permanence.

Second, Esri offers a software system that organizational data providers can easily use to create and disseminate open data (06-Esri-D, 09-Esri-O, 10-StO-C, 11-Prov-B, 16-Prov-C). It includes hosting the data in a cloud environment and publishing it as a ready-to-use service accessible through open application programming interfaces (APIs). ArcGIS Hub is the main product that delivers this value proposition. As of early 2018, over 5000 government organizations, academic institutions, and others have published open data through ArcGIS Hub (Lafia, Turner, and Kuhn 2018). An account is not required to search, access, and reuse open data published through ArcGIS Hub.

Third, Esri Inc. and its distributors occasionally take on special projects related to open data, either on their initiative or in collaboration with other organizations (01-Esri-A, 02-Esri-B, 04-Esri-C, 06-Esri-D, 09-Esri-O, 16-Prov-C). Most of these projects aim to deliver social value from open data by making it accessible to the broadest audience possible. An excellent example is Esri's support of the COVID-19 Dashboard by Johns Hopkins University (JHU) by helping the JHU team with data scraping, automating the process of importing data, and scaling the infrastructure to withstand tremendous volumes of traffic (Barone 2021; Geraghty 2023; Milner 2020; Perkel 2020). Another example is the collaboration between Esri Netherlands and the Cadaster, Land Registry, and Mapping Agency (Kadaster) to develop a web application called Topotijdreis (topo time travel), which presents historical 200-year topographic maps of the Netherlands (Esri Nederland 2023). Meanwhile, Esri UK developed free GIS-based teaching resources based on the UK Meteorological Office's (Met Office) open data to help school children learn about climate change (Davies-Holloway 2021; Esri UK 2021). On its own initiative, Esri Spain developed a portal analyzing and visualizing traffic accidents in Madrid based on open data from the city council (Esri España n.d.).

Fourth, Esri offers consultancy services to open data providers and reusers (01-Esri-A, 04-Esri-C, 07-Esri-E, 08-Esri-E). As described by interviewee 01-Esri-A, 'If I see the value of Esri beyond just the software, it's that we speak to everybody. We know the big problems. We know the little problems. And if we can fix them because we can see the shape of the jigsaw piece in the middle, then we can do that'. A pertinent example of Esri providing consultancy services to an open data provider is Esri UK's work with the Met Office to improve how the latter publishes climate data. However, not all Esri distributors provide consultancy services, as at least one (05-Esri-D) explicitly said they do not do so due to a lack of resources.

5.2 | The How: Esri's Open Data Intermediation Value Creation

Most of the resources and activities Esri deploys to offer its open data intermediation value propositions are also those required to maintain and develop its software offering (09-Esri-O). The enabling technology, in terms of desktop software for creating data and server software for disseminating data, has been around and continuously developed before Community Maps, Living Atlas, and ArcGIS Open Data (ArcGIS Hub) were even introduced (09-Esri-O). Esri claims to invest approximately 30% of its annual revenue into research and development (Esri n.d.-a). Once customers subscribe to ArcGIS, they are supported by Esri's customer service, which ensures that the software, including open data-related products, is suited to their needs (11-Prov-B, 16-Prov-C).

Esri invested in an extensive physical and network infrastructure to host and make available petabytes of data to users in a highly scalable, reliable, and performant way (09-Esri-O). The company began this process in the early 2000s by purchasing physical hardware, establishing data centres, and developing technology to manage the infrastructure (09-Esri-O). Nevertheless, it was still not sufficiently reliable and scalable

(09-Esri-O). Hence, in the last 5 years, the company has been migrating all of its infrastructure to the cloud, and almost all of Esri's content is now hosted in commercial cloud infrastructure. This, for example, made it possible for Esri to support JHU's COVID-19 Dashboard, which reached a peak of a billion hits per day (09-Esri-O).

To provide data in ArcGIS, such as the basemaps and other data in the Living Atlas, Esri performs the tasks of searching for, processing, and curating data (01-Esri-A, 02-Esri-B, 03-Esri-C, 05-Esri-D, 07-Esri-E). Esri also regularly updates datasets as they are made available by data providers, often through customized data routines that automatically download data from their sources on a scheduled basis, integrates them into the data model, and publishes them (02-Esri-B, 04-Esri-C, 05-Esri-D). In addition, Esri develops governance tools to inspect data nominated into the Living Atlas, communicate with data contributors, and accept it into the Living Atlas (09-Esri-O).

Esri also monitors the use of content in ArcGIS Online. This is to ensure that data request times are still within seconds and to keep abreast of local or global news that may result in traffic hikes (04-Esri-C and 05-Esri-D). For instance, Esri Netherlands has a large, self-developed monitoring environment including push notifications on mobile phones. This helped it react swiftly to events that require scaling up its infrastructure, such as the large flood in the south of the Netherlands in 2021, during which elevation maps were in high demand.

Some distributors also develop their own Esri national open data portal or service, separate from the Living Atlas. For example, Esri Germany Open Data Portal compiles geospatial data on Germany in various open formats, accessible to anyone, including non-ArcGIS users (Esri Deutschland n.d.). The portal includes data on various topics, such as public safety, traffic, and the environment. This is in the context of a heterogeneous open data landscape in Germany, where every federal state decides on the open data it provides and how the data is provided. Meanwhile, Geoinfo Denmark offers Geoinfo DataLeverance (Geoinfo n.d.), a free open data delivery service for ArcGIS users who sign up for the service. Data is delivered in file geodatabases via Secure File Transfer Protocol (SFTP).

Esri has been organizing the Esri User Conference every year since 1981 (Esri 2010b). It is the largest GIS practitioners' gathering in the world, where Esri showcases the new development of its technology and the applications of its software, including those involving open data. The conference also features exhibitions from over 200 organizations, including large companies (e.g., Airbus, AWS, and Maxar), government organizations, and academic institutions. In 2023, the event gathered nearly 18,000 in-person attendees from around the world and over 20,000 online viewers (Esri 2023a). Additionally, Esri distributors hold local conferences annually (Esri Deutschland 2024; Esri España 2024; Esri Nederland 2024; Esri UK 2024; Geoinfo 2024), providing local organizations the opportunity to update themselves with GIS advancements and connect with other organizations in the country. Besides annual conferences, Esri ensures continuous customer engagement through other ways. For example, Esri Netherlands offers a content hub containing information on the open data it curates, including data changes log and recent data updates (Esri Nederland n.d.). The content hub also provides inspiration on open data applications and tutorials on dealing with certain open data.

In some instances, Esri mediates feedback about open data from users to providers. Interviewee 07-Esri-E noted, 'A lot of end-users, especially ArcGIS users, will contact us if they have problems with gathering or accessing the data. After a few calls from different customers, we will start to look into it. [...] So we are having some dialogue with the provider based on users' feedback and our own experience as well'. Additionally, the Head of Climate Services of the UK's Met Office was offered centre stage during the 2022 Esri UK Annual Conference to solicit input on the agency's new data portal (Esri UK 2022).

5.3 | The Why: Esri's Open Data Intermediation Value Captures

Esri captures value as an open data intermediary in *five* main ways. The *first* is through cross-subsidies. Intermediating open data creates a greater appeal for ArcGIS (11-Prov-B, 16-Prov-C, 17-Prov-B, 25-User-C). It is not only the software's capabilities that may attract customers but also its ready-to-use data, which reduces customers' burden of compiling and pre-processing data. The top-level executive from Esri Inc. interviewed that the company has seen exponential growth in its software adoption since around 2010. While this could be attributed to many factors, he stated that 'at the top of the list is the ability of users to access ready-to-use content, including open data content,' and inversely, 'the ability of them to share information'. Some Esri distributors (02-Esri-B, 04-Esri-C, 05-Esri-D, 07-Esri-E) also associated open data intermediation offerings with more software sales or at least mentioned this as one of their goals.

Second is through nonmonetary marketing. By undertaking special projects related to open data, Esri aims to increase its visibility to a broader audience. These projects can demonstrate what ArcGIS can do. In the case of Esri UK working with the Met Office to offer free GIS-based climate change teaching resources, the interviewee from Esri UK shared, 'We wanted them [Met Office] to co-brand our resources into schools and universities, so we asked them for help on the climate science and the validation. They asked for help transferring knowledge to their GIS team. So, we got something out of it. They got something out of it. No money changed hands. It was just time'. Similarly, interviewee 04-Esri-C remarked, 'The more public good promotional apps are out there, the more people use them and see that they are powered by Esri. So that is more like marketing and brand awareness. That is a value for us'.

Third is through the freemium model. Esri also purchases datasets from commercial data providers, such as street data from Maxar and micro-boundaries data from Michael Bauer Research, since these datasets are not available as open data (09-Esri-O). While some of these purchased datasets are then provided for

TABLE 2 | Evolution of Esri's (open) data intermediation.

Year	(Open) data products/services by Esri
1996	**ArcData** (*Retired by 2003*)
	Esri provided hundreds of ready-to-use datasets from Esri and other companies participating in its ArcData Publishing Program. Some datasets were downloadable free of charge
1998	**Data Hound** (*Retired by 2001*)
	Esri introduced a search engine that brought users to external websites offering freely downloadable data compatible with Esri software
2000	**Geography Network** (*Retired in December 2009*)
	Esri introduced a website to access, share, and download geographic content worldwide, consolidating ArcData and Data Hound with additional features. Most of the content was free. Geography Network was retired in 2009 as the services were incorporated into the ArcGIS Online web-based software package introduced in the same year
2010	**Community Maps Program** (*Active*)
	Esri welcomed organizational users to share their local data to improve the suite of basemaps created and hosted by Esri and offered to ArcGIS users
2014	**ArcGIS Open Data** (*Active, rebranded as* **ArcGIS Hub**)
	Esri introduced ArcGIS Open Data as part of the ArcGIS Online software package to facilitate open data dissemination
2014	**Living Atlas of the World** (*Active*)
	Esri launched a platform where Esri Inc. and its distributors actively curate geographic information (maps, apps, data layers) beyond basemaps and imagery
2023	**Overture Maps Foundation** (*Active*)
	Esri joined a collaboration founded by AWS, Meta, Microsoft, and TomTom to create reliable, easy-to-use, and interoperable open global map data

free to ArcGIS users, some as paid datasets (called premium data). Additionally, some datasets are initially obtained as open data but offered as premium data due to the intensive work involved in pre-processing and making them available in ArcGIS (09-Esri-O). Customers may find it convenient to purchase the premium data due to it already being contained in the ArcGIS system, where a vast quantity of other datasets, including basemaps, are already free to use.

Fourth is through consultancy fees. Some organizations require additional assistance in using ArcGIS, including related to their (open) data management. They typically have a service-level agreement that includes a certain number of days per year for consultation, but some may require more. Consultancy services are not only sources of revenue in and of themselves, but, more importantly, they are how Esri wants to retain its customers by supporting them with Esri products (01-Esri-A, 04-Esri-C, 08-Esri-E). Besides, by offering best practice advice to open data providers, Esri aims to help open data users among its customers obtain more usable data (01-Esri-A, 07-Esri-E).

Fifth, by intermediating open data, Esri benefits from self-learning. Through obtaining open data from various sources, pre-processing, and publishing it using ArcGIS, Esri and its distributors use the software 'as if [they] were the customers [themselves]', citing interviewee 04-Esri-C. Consequently, they do and learn a lot. '[We] eat [our] own dog food', said interviewee 06-Esri-D. The explicit and tacit knowledge they gathered from learning by doing may then be shared with their customers and used to improve their software and services). Table 3 shows how Esri captures value through its value propositions.

6 | Strengths, Weaknesses, Opportunities, and Threats of Esri's Open Data Intermediation Business Model to the ODE

Note that while we were inspired by the SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis that is popular in management studies (Helms and Nixon 2010), we based our analysis on the temporal dimension (current strengths and weaknesses, and potential opportunities and threats) rather than internal versus external dimensions (i.e., the manner in which the SWOT analysis is conventionally used). Hence, we do not refer to our analysis as a SWOT analysis. In this article, we analyzed the strengths, weaknesses, opportunities, and threats of Esri's open data intermediation business model from the overall ODE point of view.

6.1 | Current Strengths

6.1.1 | Driving Values to Open Data Providers and Users

Esri's venture into open data has far more to do with improving its software's experience and sales than altruism. Arguably, this makes Esri's role as an open data intermediary rather enduring, as its cessation would hinder Esri's competitive advantage, at least until a (new) player with a new business model renders Esri's role irrelevant. We analyze the applicability of value drivers identified by Amit and Zott (2001) and Visnjic et al. (2017) to the Esri case.

Since introducing (open) data intermediation services as early as the 1990s, Esri sets the bar of what to expect from GIS software. Beyond just offering a set of GIS tools, Esri has long facilitated (open) data publishing and reuse by its customers. Hence, at least to a certain period, Esri drives (or drove) novelty value through its open data intermediation business model. By including open data in its software, Esri drives the efficiency value since, for many use cases, ArcGIS users could skip searching for and pre-processing datasets as they are already integrated into the software (16-Prov-C, 17-Prov-B, 24-User-C, 27-User-D). ArcGIS users can also publish their

open data easily with ArcGIS software (particularly with ArcGIS Hub).

Open data providers occasionally institute structural changes to their data, which can impact users who implement automated data routines for data retrieval and pre-processing. However, as Esri takes care of fixing the data routines on its side, customers may not have to deal with this kind of disruption (04-Esri-C). This not only contributes to the efficiency value but also the accountability value where Esri manages risks on behalf of its customers.

Complementarity is also a value that Esri offers its customers, as its software comes with petabytes of data. Beyond that, Esri offers an integrated platform for GIS services, including enterprise, desktop, mobile, and cloud-based solutions, making it easy for open data to travel across different solutions (01-Esri-A, 02-Esri-B, 07-Esri-E, 11-Prov-B). In addition, Esri provides consultancy services and support to its customers, including among open data providers and users—indeed, some spoke very positively about the support they received (11-Prov-B, 16-Prov-C). Interviewee 16-Prov-C also related such support to the accountability value: 'With Esri, we can make an agreement, we want to use your software for our jobs, and we want proper support if needed', and according to the interviewee, this differentiates ArcGIS from its open source equivalent, QGIS.

Another value driver we learned from the Esri case but is less emphasized in the current literature on value drivers is the adaptability value. We noticed that Esri customers appreciated the locally customized data, services, and projects that Esri's local distributors provided. Conversely, Esri customers expressed dissatisfaction when local customisation is lacking.

Based on the sustainable ODE features by van Loenen et al. (2021), all the five value drivers (novelty, complementarity, efficiency, accountability, and adaptability) that Esri delivers through various value propositions contribute to the user-drivenness of the ODE. To some extent, they also contribute to the circularity aspect since Esri not only captures value from open data but also gives value to the ODE actors.

6.1.2 | Leveraging Network and Technological Capabilities

Consistent with the RBV (Barney 1991), our study showed that Esri leverages its VRIN resources to intermediate open data, particularly its network and technological capabilities, which it has established for decades as the pioneer in GIS software. At this point, these resources are hardly imitable by other companies. In terms of network, for example, the interviewee from Esri Spain noted that in Spain, many public agencies are already Esri customers; hence, Esri Spain encouraged them to publish open data on the ArcGIS platform (aside from other platforms). Additionally, some of Esri's existing private-sector customers contribute open data for philanthropic or 'public good' reasons (01-Esri-A).

In terms of technological capabilities, along with the development of its software for the market, Esri has, at the same time, made it easier for Esri distributors themselves to process, curate, and host data on the Living Atlas. A couple of Esri distributors (01-Esri-A, 04-Esri-C) described that the availability of off-the-shelf Esri tools simplified their open data intermediation tasks. The cloud-based software of ArcGIS Online is leveraged for data hosting, reducing the need for Esri distributors to have large on-site servers (03-Esri-B, 04-Esri-C).

6.1.3 | Promoting Open Data

Several interviewees credited Esri for bringing awareness about open data to the broader geospatial audience and indirectly promoting its provision and reuse (17-Prov-B, 19-OSG-O, 22-User-A, 24-User-C). The interviewee from OSM Foundation shared, 'Esri have done a lot of good work to raise awareness of OpenStreetMap among their one of core customer bases, the public sector'. The interviewee from OSGeo observed, 'Esri's interaction with open data benefits Esri but also benefits everyone else because it shines a stronger light onto open data; it shows the possibility'. Another interviewee characterized Esri as a 'communicator of the open data' (17-Prov-B).

In addition, Esri also creates new types of data that were previously non-existent but had been deemed important. For example, Esri Inc. collaborated with Impact Observatory (an artificial intelligence company) and Microsoft to build the first high-resolution (10-m) global land cover map based on the European Space Agency's (ESA) Sentinel-2 satellite imagery. The map was released as open data and is updated annually in the Living Atlas and can also be used by non-ArcGIS users (Esri 2021). By promoting open data and creating new types of open data, Esri contributes to the user-drivenness and circularity of the ODE.

6.2 | Current Weaknesses

6.2.1 | Resting Upon Proprietary Software

The main weakness of Esri's open data intermediation business model is the fact that it rests upon proprietary software (22-User-A, 27-User-D, 26-User-C). Interviewee 12-Prov-E strongly suggested that Esri's business model is 'very anti-open data ecosystem'. Others characterized it as potentially gatekeeping (15-Prov-D) and exclusionary (20-User-E, 29-User-C). On the other hand, interviewee 27-User-D viewed that, as a commercial software company, it is unsurprising that Esri offers some of its open data intermediation services only through its proprietary software. Other interviewees (24-User-C, 27-User-D) perceived that, despite Esri's proprietary software, the company does not deny the coexistence of other open data platforms and open source software. Furthermore, an interviewee among data providers (16-Prov-C) believed that if their organization were to use open source software instead of ArcGIS, the organization might have to hire companies specializing in open source to handle their data management, which would still incur costs.

Esri interviewees seemed familiar with the debate of using proprietary versus open source software with open data as

TABLE 3 | Links between the value propositions and value captures of Esri's open data intermediation.

Value propositions	Value captures				
	Cross-subsidies	Nonmonetary marketing	Freemium model	Consultancy fees	Self-learning
A software system that is in itself an (open) geodata platform	X		X		X
A software system for data providers to create and disseminate open data	X				
Special projects related to open data		X			X
Consultancy services to open data providers and reusers				X	X

well as the conflation of open data and open source software. They generally emphasized the coexistence of open source and proprietary software; for instance, 'we are different technologies that live in the same space, and we try to do our best to solve the problems of the users. It is that simple. [...]. There shouldn't be, let's say, dogmatic views about the way you approach these kinds of problems' (02-Esri-B). This echoes Sui's (2014, 20) assertion that 'an artful combination of both open and proprietary practices' is likely 'the most realistic option'. In any case, since most of Esri's open data value propositions rest upon proprietary software, Esri's contribution to the circularity of the ODE is limited as not all actors can benefit from the value the company offers.

6.2.2 | Local Versus Global Tensions

Esri local distributors play a crucial role in the company's open data intermediation. They provide data for the development of basemaps, curate local open data in the Living Atlas, perform local open data-based projects, and engage with local stakeholders. This decentralized approach seems apt since every country has different open data policies and ecosystems (01-Esri-A, 04-Esri-C, 09-Esri-O). However, we observed different priorities concerning open data intermediation across the distributors. For a start, the number of items (e.g., maps and layers) curated by each distributor in the Living Atlas are starkly different: the Netherlands (1401), Spain (1047), Germany (638), the UK (439), and Denmark (77) (recorded in August 2024) (Esri n.d.-b). The number of items curated by local distributors in the Living Atlas does not reflect the availability of open geospatial data in those countries. For example, even though Geoinfo Denmark curated the least number of items among the four distributors, a large number of Danish geospatial datasets were already open data as early as 2013, including topographic data, place names, elevation products (including LIDAR point cloud, a terrain model, and a surface model), administrative units, cadastral information and parcels, location-based addresses, and orthophotos (geometrically corrected aerial photography) (Copernicus In Situ 2018; The Centre for Public Data 2024).

Beyond those numbers, the interviews corroborated the diverging priorities. For instance, an interviewee from Geoinfo Denmark explicitly mentioned their preference to share data through the distributor's own service, Geoinfo DataLeverance, instead of the Living Atlas, due to 'some administrative, technical issues'. Meanwhile, the interviewee from Esri UK shared that their approach has shifted from curating data to mainly engaging their customers to publish their data on their own through ArcGIS Online or ArcGIS Hub. There may be organizational identity at play because when asked the reason for the shift, they said, 'We're a software company. [...]. We make money from selling software and solutions. We are not a data company'.

Furthermore, based on the interviews, the numbers of staff in charge of content-related products (including open data products) differed significantly across distributors. For instance, Esri Netherlands had eight full-time employees working on content, comprising developers, data engineers, cloud engineers, cartographers, and product managers, all in one team. On the other hand, Geoinfo Denmark had less than five employees working on content, all in different teams.

Therefore, while Esri Inc. may have a particular business model outlook to open data intermediation (09-Esri-O), it is not shared uniformly across Esri distributors. This may then impact the experience of ArcGIS users. For example, an ArcGIS user from Denmark remarked, '[in ArcGIS], it was not open data that was useful for me because it was not Danish open data; it would be some American open data'. Another interviewee reported that, despite being based in one country, they occasionally engaged in projects or research on another country (or across multiple countries), for which they noticed different data availability and quality levels in ArcGIS (29-User-C). This insight shows that while decentralization strategies may help deliver the adaptability value, such strategies may also compromise other value drivers (particularly efficiency) if there are diverging views on organizational identity (e.g., software company versus more-than-software company).

That said, some interviewees highlighted that open data inconsistencies across geographical areas are not only an issue within ArcGIS but reflect a persistent problem of the broader ODE (22-User-A, 26-User-C, 28-User-C, 29-User-C). Even across subnational boundaries, fragmentation exists (01-Esri-A, 02-Esri-B, 06-Esri-D, 15-Prov-D, 23-User-D). While problems and phenomena that need to be studied with (open) geospatial

data may be transboundary, (open) geospatial data administration is not an issue that has long been recognized (McLaughlin and Nichols 1994).

6.2.3 | Limited to Geospatial Data

Esri's open data intermediation is limited to geospatial data. Several interviewees highlighted the need to consider cross-domain open data business models, including those which integrate open geospatial data with other types of open data (10-StO-C, 12-Prov-E, 16-Prov-C, 20-User-E). Some interviewees also observed the general aversion of some non-geospatial data users towards geospatial data, which is likely due to the lack of awareness and skills (11-Prov-B, 20-User-E). As Masser et al. (2008, 5–6) argued, most people are not 'spatially aware professional'. This predicament could also partly be attributed to different commonly used standards; for instance, while ISO standards are popular in the geospatial domain, DCAT standards are more prevalent in other fields (10-StO-C) (Ivánová et al. 2020). Hence, there is still a gap to bridge in reducing the barrier for users without geospatial backgrounds to use and integrate open geospatial data with other types of open data. Addressing this gap could improve the user-drivenness and skill-based aspects of the ODE.

6.3 | Potential Opportunities

6.3.1 | Learning From the Road Taken

Esri has shown possible ways (and potential shortcomings) in how open data intermediation could be performed (16-Prov-C, 29-User-C). These insights can be used by others to undertake open data intermediation, including the open source software community. The OSGeo interviewee said, 'I think what Esri has done in some way is analogous to how Windows helped Linux and some open source products'. Interviewees from Esri also observed how the open source software community often mimics or makes references to functionalities and services offered by Esri, which they perceived as positive (02-Esri-B, 04-Esri-C, 08-Esri-E).

However, Esri's approaches are not the only possible ways. The OSGeo interviewee encouraged schools, colleges, and universities to raise awareness about open source software as an alternative to proprietary software, consistent with calls in the literature (Brunsdon and Comber 2021; Kedron et al. 2021; Singleton, Spielman, and Brunsdon 2016). This is a crucial point especially in the context of Esri being heavily involved in GIS education (Curran and Bowlick 2022). This new generation could constitute a critical force to accelerate the development and adoption of open source software, encompassing new open data intermediation solutions. This is necessary for the inclusivity aspect of the ODE.

6.3.2 | Further Collaborations

There are opportunities for further collaboration between Esri and others to achieve shared goals. Interviewee 13-Prov-E wished for formal collaborations where Esri could systematically provide input and updated data back to open data providers. Interviewee 12-Prov-E proposed co-creation or sandbox collaboration where Esri could work with others in developing initiatives with shared benefits.

One significant collaboration that Esri has recently become involved in is the Overture Maps Foundation. While the foundation's claim to offer high quality open geospatial data based on OSM is desirable and the interviewee from the OSM Foundation also described Overture as 'very much a good thing', it is still too early to assess its impacts. It is worth pointing out that Overture is led by four large tech companies as steering members, with Esri as the general member. The contributor members are almost entirely comprised of for-profit companies (as of August 2024) (Overture Maps Foundation 2024). Furthermore, Ballantyne and Berragan (2024) noted that while Overture's data offers great potential, 'accessing the data relies on computational resources beyond the skillset and capacity of the average researcher' (p. 1). Therefore, active involvement or new collaborative ventures in open data intermediation by public or civil society organizations at the global scale may still be necessary to seriously account for public interests and non-expert users.

6.3.3 | Advocating for More Open Data

With Esri's network, resources, and market position, the company could significantly advocate for better open data availability and quality. Esri has already made such efforts to some extent. For example, the CEO of Esri Netherlands led the Breakthrough Project Open Geodata from 2013 to 2017, an initiative of the country's Ministry of Economic Affairs to identify and address obstacles around open geospatial data in the Netherlands. The project's outcomes include the release of the actual elevation map of the Netherlands (AHN) and satellite data from the Dutch Space Office (Blankena 2016; Doorbraakproject Open Geodata 2015). Nevertheless, gaps remain in terms of open data availability and quality in other countries, for which Esri could take a more active role in bridging. Besides, there is now limited open data from the private sector compared to the public sector (05-Esri-D, 06-Esri-D, 17-Prov-B). Therefore, Esri may contribute to the inclusivity of the ODE by incentivizing companies to share more open data.

6.4 | Potential Threats

6.4.1 | Dominant Position

Although Esri may not have explicitly denied the space for other (potential) open data intermediaries to engage in similar activities, its dominant market position, along with its VRIN resources, renders its influence and power hard to match (19-OSG-O). This translates into, for instance, its perceived reluctance to adopt open standards, at least in the early days (10-StO-C, 15-Prov-D, 17-Prov-B, 23-User-D, 24-User-C, 25-User-C), despite having been a member of the Open Geospatial Consortium (OGC)[3] as early as 1996 (Open GIS Consortium 1996).

Moreover, the company has also been perceived as steering open standards development to give itself an unfair advantage in the market (Dasgupta 2013; OSGeo 2013). However, Esri would argue that its proximity to users means that it is aware of 'real' user needs regarding standards beyond what is theoretically possible (Esri 2018; Henriksen, Lauzon, and Morehouse 1994). Echoing Dasgupta (2013), the onus is on the OGC as a consortium to provide leadership for everyone's interests. This scenario highlights the larger question of what kind of governance is required for a self-organizing ODE—beyond the issue of standards. This question is as necessary concerning Esri now as it concerns other current and future open data actors, especially for-profit companies in dominant positions (Johnson et al. 2017; Mahmoudi et al. 2024).

6.4.2 | Lock-In System

The convenience that ArcGIS offers an integrated platform may also result in high costs of switching away from the platform (10-StO-C), which could well be a double-edged sword. These costs may be due to technical restructuring of the open data infrastructure and staff re-skilling. There are various possible reasons why customers may wish to switch away from Esri products. For example, one interviewee shared that their organization was considering moving to an open source infrastructure due to the high costs of ArcGIS subscription, as the required capacity for their infrastructure was reaching the limit set in their contract (11-Prov-B). Even though lock-in is one of the value drivers identified by (Amit and Zott 2001), it is not a positive value driver to the circularity and inclusivity of the ODE.

Interviewee 10-StO-C suggested that Esri should consider compartmentalizing its functionalities further than they currently do so, in order to allow open data providers and users to choose the specific services they want. As it stands, several users reported that they use ArcGIS alongside other software, such as Python and FME, due to their perceived strengths, despite the fact that the activities they conduct with other software can theoretically be performed in ArcGIS (20-User-E, 24-User-C, 26-User-C). Hence, not all ArcGIS users require all the functionalities that come in existing ArcGIS packages. However, another interviewee considered that current Esri services are already too compartmentalized (28-User-C). Notwithstanding, it would be worth further exploring the potential adverse impacts of Esri's lock-in system as well as how these could be mitigated.

6.4.3 | Sharing Versus Shifting Responsibilities Conundrum

One interviewee alluded to whether Esri is now conducting the work that ought to be addressed at the data provision stage by original open data providers, especially among public agencies (26-User-C). Others pointed out that even though Esri has seemingly reduced the open data accessibility and reusability barriers for ArcGIS users, these barriers are still left unaddressed for non-ArcGIS users (23-User-D, 29-User-C). One interviewee among data providers stressed that there should be an active role for open data intermediation within the public sector, and such a role should not be left only to the private sector (12-Prov-E). This resonates with the call by Johnson and Scassa (2023) for governments to critically consider their role within geospatial data collection, use, and dissemination. Sieber and Johnson (2015) highlighted various roles that public organizations could perform apart from publishing open data. They could also actively encourage the reuse of open data (e.g., by organizing contests), accept contributions of citizen-generated data, and involve citizens in the decision-making related to open data.

Meanwhile, other interviewees among public organizations (13-Prov-E, 16-Prov-C) mentioned their lack of resources to regularly engage with open data users and address their needs; hence, they were appreciative of the role played by open data intermediaries outside the public sector, such as Esri. Additionally, some interviewees highlighted the blurred demarcation between the role of the public sector and the market from the eyes of competition laws (04-Esri-C, 13-Prov-E, 16-Prov-C).

Therefore, while the ODE implies that all actors share the responsibility for sustainable value creation from open data, there is no quick and easy answer regarding who should play what role, as one would expect from a purely top-down hierarchical system. It would be even more challenging to answer this question at the multinational level, since different countries have different open data approaches and preferences (Hossain et al. 2021), and issues such as competition law involve more factors beyond open data.

7 | Developing an Open Data Intermediation Business Model That Supports the Sustainability of the ODE

Based on the analysis of Esri's open data intermediation business model—and its current strengths and weaknesses and potential opportunities and threats—we recommended several factors to consider to develop an open data intermediation business model that supports the sustainability of the ODE. These factors especially apply to open data intermediation business models that share the same archetype as Esri, that is, one-stop package, but some may still apply to other archetypes.

Referring to Figure 4, for the one-stop package archetype, the core products or services are at the centre of the business model (in the Esri case, it is the ArcGIS software). Open data intermediation services should be developed around the core products/services. This means that offering open data intermediation services should not require radically different resources and activities from the core products/services. It also means that the core products/services and the open data intermediation services are mutually interdependent—the attractiveness of the open data intermediation services should ideally drive customers to engage with the core products/services. This tight integration between core products/services and open data intermediation services is consistent with theories of the RBV (where organizations gain competitive advantage by leveraging their VRIN resources) and the organizational identity theory (where the notion of 'who we are' drives strategic decisions).

Both the core products/services and the open data intermediation services, as a package, should drive novelty, complementarity,

efficiency, accountability, and/or adaptability values. Value drivers should be delivered through (multiple) value proposition(s) that are designed with clear connections to ways of generating profit or other types of benefits (value capture). Furthermore, to support a sustainable ODE, the design of the open data intermediation business model should pay attention to the user-drivenness, circularity, inclusivity, and skill-based aspects of the ODE. Since open data intermediaries are also part of the ODE, the sustainability of the ODE may also impact open data intermediaries, at least in the long run. Table 4 outlines in more detail 14 factors to consider for developing an open data intermediation business model with example insights from the Esri case.

Beyond identifying factors to consider in developing an open data intermediation business model, our study also revealed several interrelated aspects that require further research. First, our study calls into question how various responsibilities in the ODE should be allocated to ensure that diverse open data needs are addressed and public interests are protected. As shown, most of Esri's open data intermediation value propositions are only enjoyed by its customers, who can afford to subscribe to its proprietary software. Hence, challenges that Esri addresses may remain unaddressed for non-Esri customers. The situation is further complicated by existing competition laws that limit open data providers among public organizations from offering products and services similar to private sector open data intermediaries.

Second, our study reasserts the critical role of governing institutions (not only governments but also standards bodies such as OGC) in ensuring that the dominant position of any actors in the ODE does not jeopardize or overlook other actors' growth and mutual interests (Johnson et al. 2017). Furthermore, as highlighted by several interviewees from Esri (04-Esri-C, 06-Esri-D, 09-Esri-O), open data intermediation requires the availability of open data, first and foremost. Although open data intermediaries can also play a role in advocating for open data availability, their contribution could only go so far in the absence of legislation, policies, or organizational/political commitment on open data. In sum, without a forward-looking and robust governance system, the design of an open data intermediation business model alone cannot guarantee the sustainability of the ODE. In fact, the business model may perform well for open data intermediaries but at the expense of other ODE actors.

Third, our study reaffirms the importance of the entire technology stack to the sustainability of the ODE. It is not only the characteristics of the open data (coverage, quality, format, license, etc.) that are important to the sustainability of the ODE but also how it is disseminated and reused, including the software used. Open source software that provides open data intermediation solutions is more desirable than proprietary software from the point of view of the ODE, since actors that may especially require open data intermediation services, such as grassroots groups (Elwood 2008), have limited financial resources. However,

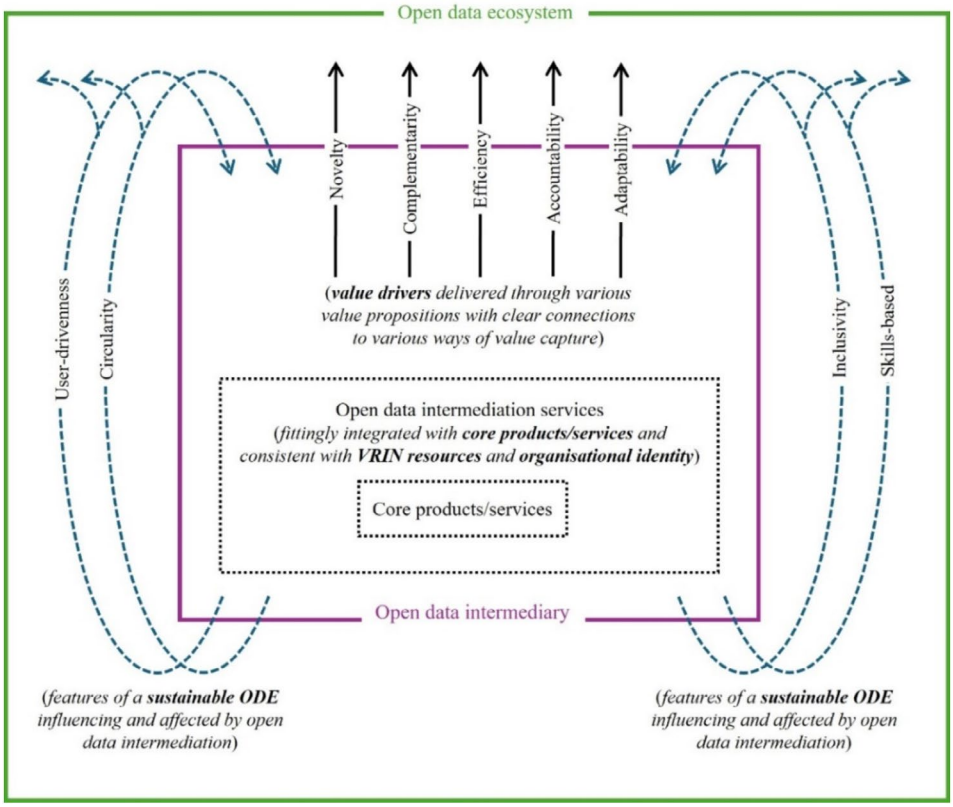

FIGURE 4 | Visual representation of factors to consider in developing an open data intermediation business model that supports the sustainability of the OD.

TABLE 4 | Factors to consider in developing an open data intermediation business model that supports the sustainability of the ODE.

Categories	Factors to consider	Example insights from the Esri case
Open data intermediation services	(1) Ensure open data intermediation services offered are fittingly integrated with the existing core products or services	Esri's open data intermediation is firmly linked to its business interests of improving its software's appeal and visibility, rather than to a philanthropic or ad hoc endeavor. This situation of 'having skin in the game' arguably renders its open data intermediation business model enduring
	(2) Ensure open data intermediation services offered are consistent with VRIN resources	Esri plays to its strengths by leveraging its existing network and technological capabilities in its open data intermediation instead of starting from scratch
	(3) Ensure open data intermediation services offered are consistent with organizational identity	Esri's open data intermediation does not involve a significant shift from its core business as a software company
	(4) Ensure consistency in how members understand organizational identity, especially as the organization becomes more decentralized	Esri Inc. and Esri distributors have diverging approaches towards open data intermediation, partly contributed by different views of the company's organizational identity. This impacts the experience of its customers in different countries who engage in its open data intermediation services
Value drivers	(5) Value drivers should be delivered through value propositions with clear connections to value capture	Esri generally offers four open data intermediation value propositions intricately linked to five value captures
	(6) Consider novelty value driver	Esri has set the expectation for a GIS software package that comes with ready-to-use data. While this may now be taken for granted, Esri's (open) data intermediation evolution since the 1990s shows that what Esri offers now results from conscious strategic decisions over decades
	(7) Consider the complementary value driver	Besides the ready-to-use data within ArcGIS, Esri also offers consultancy services and conducts special projects related to open data
	(8) Consider the efficiency value driver	Esri simplifies the process of reusing and disseminating open data within ArcGIS
	(9) Consider the accountability value driver	Esri customers may not need to deal with occasional open data structural changes implemented by data providers as Esri manages such disruptions. Esri, thus, manages the risks of data inconsistencies due to changes made by open data providers
	(10) Consider the adaptability value driver	Esri customers appreciate the locally customized data, services, and projects that Esri's local distributors provide
Sustainability of the ODE	(11) Consider the user-drivenness aspect	Esri offers various value propositions that mainly address open data users' challenges. However, Esri's open data intermediation rests on proprietary software, thereby restricting non-Esri customers from benefitting from its services. Hence, there are gaps for open data intermediation integrated solutions based on open source software
	(12) Consider the circularity aspect; in particular, ensure that VRIN resources are not leveraged in ways that unfairly stifle the growth of other actors	Due to Esri's dominant position, it may directly or indirectly hinder other open data actors from also capturing value from the ODE (e.g., Esri being seen as influencing open standards to give itself an unfair advantage in the market). Open data intermediation business models supporting the ODE's circularity aspect should avoid the winner-takes-it-all situation, e.g., by fully committing to technical interoperability
	(13) Consider the inclusivity aspect	There is room for Esri (and other open data intermediaries) to advocate for more and better open data from non-public sectors
	(14) Consider the skills-based aspect	Esri provides consultancy services to its customers, as well as publicly accessible tutorials and examples on using open data

currently, while there is a wide range of open source tools available, understanding which tool and combination of tools are appropriate for specific purposes takes time (Lovelace 2021), especially when documentation for open source software is often not as clear and detailed as proprietary software (Yap, Janssen, and Biljecki 2022).

8 | Conclusions

This article has addressed the research question: what factors should be considered in developing an open data intermediation business model that contributes to the sustainability of the ODE? We tackled this question through the case study of Esri, a significant player in the geospatial domain that has long been an open data intermediary and by addressing three objectives.

The first objective is to detail Esri's open data intermediation business model. Our study showed that Esri generally offers four open data intermediation value propositions: (1) a software system that in itself is a (open) geodata platform, (2) a software system for data providers to create and disseminate open data, (3) special projects related to open data, and (4) consultancy services to open data providers and reusers. Esri benefits from offering these value propositions through five intricate ways: (1) cross-subsidies, (2) nonmonetary marketing, (3) freemium model, (4) consultancy fees, and (5) self-learning. In delivering those value propositions, Esri mostly mobilizes resources and activities that are already required to maintain and develop its software offering. In addition, Esri performs the tasks of searching, processing, curating, and updating data, mainly for the basemaps and the Living Atlas. Some Esri distributors also develop their own Esri's national open data portal or service.

The second objective is to consider the strengths, weaknesses, opportunities, and threats of Esri's open data intermediation business model to the ODE. Our study highlighted three strengths: through its business model, (1) Esri drives values to open data providers and users, by (2) leveraging its existing networks and technological capabilities, while also contributing to the (3) promotion open data. Three weaknesses were identified: Esri's business model is (1) resting upon proprietary software, challenged by (2) local versus global tensions, and (3) limited to geospatial data. There are three potential opportunities that could be further harnessed: other open data intermediaries could (1) learn from the road taken by Esri (including its pitfalls), ODE actors should forge (2) further collaborations with Esri, and the company should play a bigger role in (3) advocating for more open data, especially in countries where open data availability and quality are poor. Meanwhile, three potential threats should be managed: Esri's (1) dominant position and (2) lock-in system may jeopardize the interests of other ODE actors, while its far-reaching involvement in the ODE called attention to the (3) sharing versus shifting responsibilities conundrum.

The third objective is to formulate factors to consider in developing an open data intermediation business model that contributes to the sustainability of the ODE. Based on the Esri case, we recommended 14 factors to consider. They are related to how open data intermediation services should be offered (e.g., ensure open data intermediation services are consistent with VRIN resources and organizational identity), value drivers that should be considered (i.e., novelty, complementarity, efficiency, accountability, and adaptability), and features of a sustainable ODE that should be paid attention to (i.e., user-drivenness, circularity, inclusivity, and skills-based). Beyond these 14 recommendations, we also highlighted the importance of governance, as business model designs alone cannot guarantee the sustainability of the ODE.

Several limitations in our study deserve further research. First, our study is based on a single-case study of a company that has long been a leader in GIS software. There are advantages to our methodological approach. As argued by several methodological scholars (Mariotto, Zanni, and Moraes 2014; Siggelkow 2007), precisely because a case is exceptional or remarkable, a single-case study stands to offer revealing insights that may not be captured through a multiple-case study, since the latter focuses on common or comparable features. Having said that, further research is necessary to investigate the transferability of insights from our study to other cases. For instance, would insights from our study be transferable to open data intermediaries outside the geospatial data field?

Second, open data intermediaries can exist in various shapes and forms, employing different archetypes of business models. Certain insights from our study may not apply to all open data intermediation business model archetypes. For example, our study suggested that open data intermediation services be integrated with the core products/services of the organization. However, certain business models do not differentiate the core products/services from open data intermediation services, as the business model entirely rests on providing open data intermediation services. Therefore, further research is necessary to investigate factors to consider in developing open data intermediation business models of other archetypes.

Third, Esri has been intermediating (open) data for decades. Therefore, it might enjoy certain privileges unavailable to nascent open data intermediaries, such as its large customer base. The evolution of Esri's (open) data intermediation services presented in this article showed that they did not develop overnight but instead were gradually improved and refined over the years. Esri has been offering these services since its customer base was a lot smaller. Hence, one potential opportunity that other open data intermediaries can exploit is learning from the road taken by Esri. Having said that, it is still worth investigating unique challenges that nascent open data intermediaries may face nowadays, considering the maturity of (geospatial) data domains and related technologies compared to three decades ago.

In conclusion, this article has unpacked Esri's (open) data intermediation business model and analyzed its strengths, weaknesses, opportunities, and threats to the ODE. This article recommended 14 factors to consider in developing an open data intermediation business model that supports the sustainability of the ODE, which may be useful not only in open geospatial data ecosystem but also others.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are openly available in 4TU.ResearchData at https://doi.org/10.4121/f86d0e4c-851f-4378-a1bc-41210235ad61.

Endnotes

[1] Map services contain one or more data layers, depending on the map's purpose.

[2] Basemaps are reference maps on which one overlays data from other layers and visualizes graphic information.

[3] Open Geospatial Consortium (OGC), formerly Open GIS Consortium, is an international consortium aiming to make geospatial data FAIR (Findable, Accessible, Interoperable, and Reusable), including by developing open standards (OGC 2024).

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