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Navigating Open Data Ecosystems

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Navigating Open Data Ecosystems: Exploring Engagement in the Use of Local Governments Open Geodata

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Abstract

This research paper examines the use of open geodata provided by local governments in Denmark within an open data ecosystem. It aims to understand how this influences the engagement of participants using the local government's open geodata to achieve specific purposes within an open data ecosystem. The study involves seven organisations utilising local government open geodata on outdoor facilities. The findings suggest that various interrelations in the open data ecosystem influence engagement in using local government open geodata. The results also show that the interrelations in the open data ecosystem can differ depending on the stages of utilising local government open geodata. These stages are categorised on their objectives as (1) obtain, (2) transform, and (3) sustain local government open geodata use. The hypothesis proposes that exploring the underlying purposes and the interrelations across the stages of utilising local government open data can illuminate strategies to enhance the impact of local governments' open data initiatives. The research aims to provide a theoretical framework for evaluating and monitoring local government open data use from an open data ecosystem perspective, benefiting policymakers, practitioners, and researchers. Further research is needed to explore whether using the theoretical framework can serve as an analytical tool that provides insights into developing strategies.

CCS Concepts

• **Information systems**; • **Data management systems**; • **Database administration**;

Keywords

Open Data Ecosystem, Local Governments, Open Geodata, Interrelations, Engagement

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1 Introduction

In recent years, there has been an increase in the availability of government data to the public [1]. According to the European Commission, this data is essential for the success of the information economy infrastructure [2], as it can improve transparency, efficiency, and citizen participation in public services, which are crucial for achieving the UN Sustainable Development Goals [3]. However, effectively using this data presents challenges, including mismatches between the shared datasets and those demanded by the public [4]. Researchers argue that the full potential of open government data can only be realised through collaborative efforts that extend beyond the government [5]. However, current approaches often exclude contributions from other participants, limiting collaboration across organisational and administrative borders and disciplines and discouraging engagement [1].

The open data ecosystem (ODE) concept was proposed to move beyond a purely technological perspective and instead prioritise relationships and interdependencies that emphasise the social and political factors that shape these ecosystems to prevent linear functioning [6]. According to this view, one of the first steps is incorporating users' perspectives to foster circular, inclusive, and sustainable value creation in ODEs [1]. However, despite the growing interest in open government data, empirical research still needs to incorporate the user perspective into the ODE lens [7]. Furthermore, research often explores open data broadly and superficially [8] instead of focusing on specific scales or data types in the ODE [9], such as the use of local government open geodata.

While the commitment to open data is not uniform across local governments [10], its availability can benefit private companies, civic hackers, and non-profit organisations [11]. The scarcity of empirical evidence on local government open data utilisation challenges understanding the intricate and reciprocal nature of the



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relationships between the ODEs' components. For example, a study in the United States discovered that local-level ODEs are expanding, leading to changes in local government services and government personnel's responsibilities. However, the absence of monitoring mechanisms limits understanding their broader impacts [9].

To the best of our knowledge, this study represents a first effort to empirically explore how the interrelations and underlying meanings within the use of local government open geodata (OG) influence engagement in an ODE. Using a theoretical framework from previous research [12], we identified the interrelations involved in using open government data and its underlying meanings. We analysed the use of local government OG on outdoor facilities from Denmark that are available through an open government data initiative. We aim to improve the understanding of the practical implications of adopting an ODE perspective and provide theoretical insights for evaluating the engagement with local government open data utilisation.

2 Background

The concept of 'ecosystem' refers to a "system of people, practices, values, and technologies that coexist in a particular local environment" [13]. In the literature on open data, an ODE is described as a sustainable, demand-driven environment where mutually interdependent agents create and deliver value from open data cyclically [1]. The ODE conceptualisation highlights the interdependence of users, technology innovators, government leaders, data managers, and policymakers toward a common goal [6]. However, research has shown that the existing ODEs tend to be supplier-driven, limiting open data's usefulness and potential value. Incorporating user perspectives is crucial to engaging ODE participants and enabling circular, inclusive, and sustainable value creation [1], [14].

Understanding the use of open data goes beyond technical and economic aspects [15]. It is influenced by specific values and conventions that define what is considered "good" [16], [17]. Evidence suggests that open government data often involves a subjective element that prioritises the values of certain participants [8], sometimes neglecting underrepresented groups [18]. However, current benchmarks and academic models often focus solely on data provision or potential value creation rather than deeply looking at the actual impact of open government data [8]. Additionally, there needs to be more clarity between the outcomes and goals of open government data initiatives, indicating the need to address societal issues, consider the context, and adapt goals to implementation phases [19]. While the ODE perspective aims to offer a more integrated view of open government data use, further empirical research is needed to improve practical understanding and provide insights into the impact of local government open data utilization.

A purpose-directed approach can minimise biases and conflicts by considering the demand for and supply of data, and the broader social, political, and economic context in which the data is produced and used [20]. This study builds on previous work and uses a theoretical framework developed through a systematic literature review [12]. The framework identifies the interrelations involved in using open government data and its underlying meanings within open-data ecosystems based on the work of Capra and Luisi [21]. According to the framework the underlying meanings of using open

government data can be categorized as *solution-driven*, *collaboration-driven*, and *knowledge-driven* (see Figure 1). *Solution-driven* meanings involve using open government data to achieve specific outcomes or solve problems, such as improving serviceability, fostering innovation, or influencing policymaking. *Collaboration-driven meanings* refer to open government data enabling collaboration through transparency, trust, legitimacy, self-reliance, social control, accountability, and improving communication, engagement, or negotiation. *Knowledge-driven meanings* relate to the knowledge participants can gain when using open government data, including automated knowledge, contextual understanding, social empathy, informed decision-making, community knowledge, and critical consciousness. The framework also considers the material embodiments of open government data use, such as public services, co-creation spaces, and representation tools.

As illustrated in Figure 1, the interrelations within the framework refer to the generative relationships that define the patterns of organisation within the ecosystem related to the use of open government data. These interrelations are then translated into *technological*, *operational*, and *strategic*-related processes. The *technological* interrelations involve the relationships and interactions regarding the technological infrastructure necessary to the meaningful use open government data, such as software, digital interactive features, data formats, data quality, and data architecture. The *operational* interrelations entail interactions related to the activities required for meaningful open government data use, such as collecting, standardising, analysing, and enriching data. Finally, the *strategic* interrelations encompass patterns of relations guiding the long-term use of open government data, including norms, regulations, ethical considerations, programs and projects, compensations, incentives, synergies, goal setting, funding, specialised groups, and training. These categories of interrelations and the underlying meanings in the use of open government data were used as analytical tools to understand engagement with the use of local government OG, which is materially embodied by the Danish public-facing data repository that is the central focus of this study.

2.1 Context of the study

The study focuses on a Danish public-facing data repository that is part of a government OG initiative. The initiative is a collaboration between the Danish central government agency responsible for data supply and infrastructure and an association and interest organisation that serves municipalities throughout Denmark. The initiative aims to maintain a national geographical map known as basic data, an essential resource for public administration and economic development. This basic data is classified as such, making it available for free through a national data platform.

The government's OG initiative is also involved in other data projects and has subject-specific datasets of local government OG containing datasets used in public administration, which is known as GeoFA. The government's OG initiative provides foundational elements required for maps, such as roads, buildings, and water features. Meanwhile, the local government OG subject-specific dataset (GeoFA) offers specific data for various domains, such as outdoor facilities, roads and traffic, school planning, and mobility. For this study, we focused on the uses of local government OG on

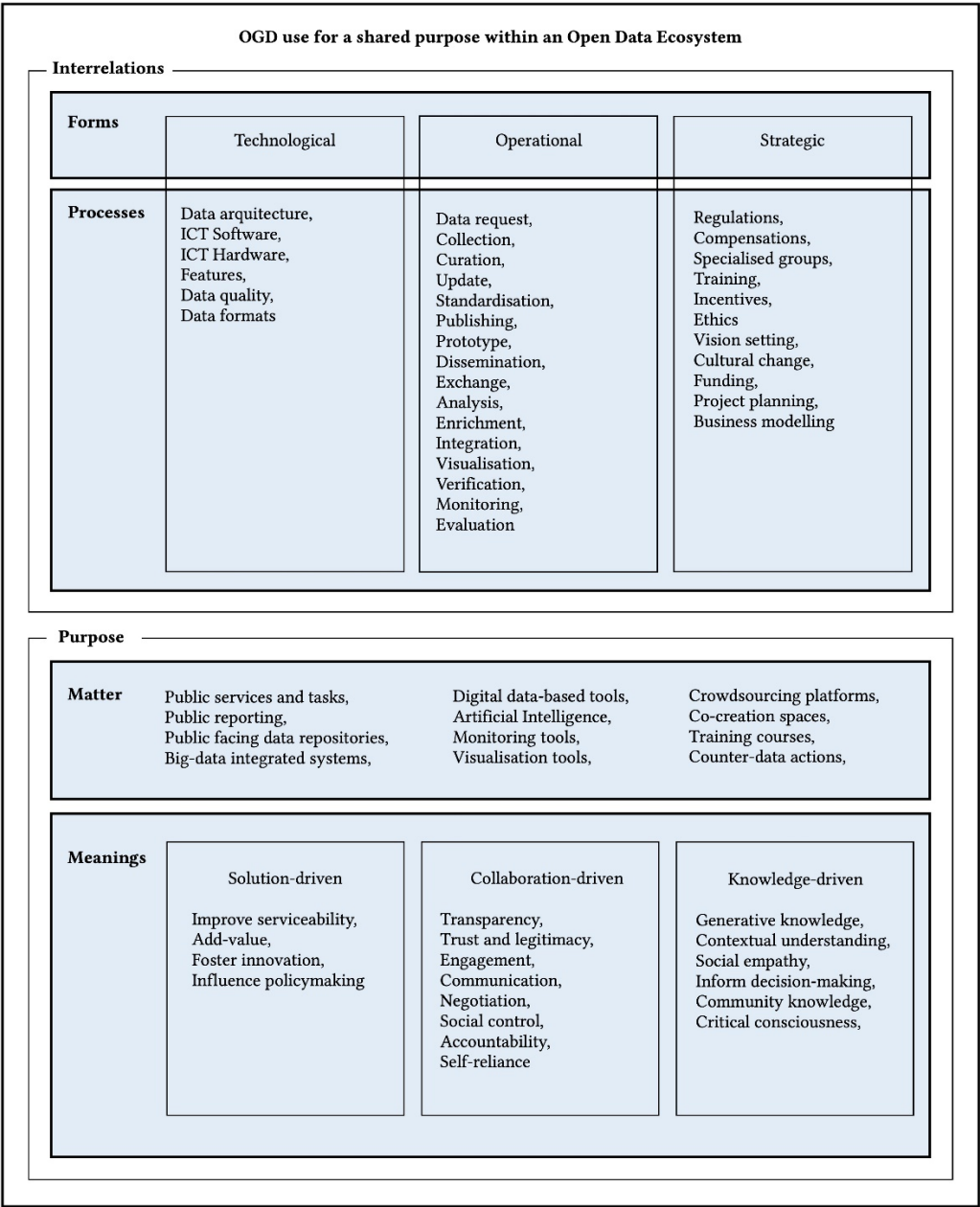


Figure 1: Framework of the purpose and the interrelations involved in using OGD within open-data ecosystems [12]

outdoor facilities available through the subject-specific dataset of the Danish open government geodata initiative.

The data provided by the OG initiative can be considered open government data because it is non-privacy-restricted and non-confidential data funded by public resources, readily available for use or distribution without restrictions [22]. Other Danish initiatives also provide open government data but need a national data

model, making it difficult to compare the data as they are spread throughout the country. In contrast, the local government OG subject-specific dataset in focus proposed a data model for all its data. Even though its use is optional, and data is not available from all municipalities, it is highly flexible and adaptable, making it cost-effective for users. The data is available in standard exchange

formats and is free of charge, making it easily accessible to public authorities, businesses, NGOs, and citizens.

3 METHODOLOGY

This study is part of an ongoing Systemic Design research focused on supporting the design of strategies to enhance the impact of local governments' initiatives in achieving the intended purposes within open data ecosystems. *Systemic design* is a transdisciplinary approach that challenges traditional user-centred methods by emphasising the interconnected nature of the world. It acknowledges that improving individual parts of a system does not necessarily improve the whole [23]. Instead, it focuses on relationships rather than isolating individual components [24] and involves collaborating with system participants to address complex issues at their roots [25]. Unlike traditional systems thinking approaches, systemic design suggests a practical and critical application [26], describing interrelations and networks of connections, contexts, and environments [27].

Even though the systemic design processes do not follow a fixed sequence of activities [28], the research study can be summarised through four of the seven phases suggested by Jones and Ael. These phases are framing the system, listening to the system, understanding the system, and envisioning desired futures [29]. The phase of framing the system involved developing the theoretical framework to identify the interrelations and underlying meanings in an ODE that influence the achievement of the intended purposes of using local government open data (see section 2). The current study focuses on the project's second phase, which entails learning from the experience of system stakeholders [29]. We employed a multiple exploratory case-study approach to understand how the interrelations and underlying meanings influence engagement in using local governments' OG within an open-data ecosystem. This approach is suitable as it allows for independent confirmation of emerging constructs and propositions and can reveal complementary aspects of the phenomena [31]. An exploratory approach was chosen as local government OG is expected to have diverse purposes, thus helping to get a comprehensive overview of how the interrelations and underlying meanings influence engagement in using local governments' OG within an open-data ecosystem.

We conducted semi-structured interviews with key stakeholders in seven selected cases. These interviews were instrumental in providing qualitative insights into the perspectives and experiences of organizations in utilizing local government OG. The interview protocol was built upon the proposed theoretical framework [12] (see Figure 1), creating a clear and organized structure and ensuring its effectiveness and efficiency [32]. Seven participants were selected based on their organizational roles and responsibilities, including project managers, coordinators, and project developers within the domain and technical knowledge (see Table 1). We used a cross-case analysis [30] to identify patterns and themes across the selected cases based on the theoretical framework of the ODE interrelations and underlying meanings [12]. This approach allows us to uncover underlying patterns and validate the themes presented in the theoretical framework. Initial coding was conducted to identify key concepts and develop categories connected

to the themes in the framework. Triangulation was used to cross-validate interview information with additional data sources, such as organizational documents and archival records made available online or shared by the organisations linked to the case studies. The analysis results were then used to complement the framework and present an iteration to enhance the understanding of how the interrelations and underlying meanings influence engagement in using local governments' open data within ODE.

3.1 Case Selection

We have chosen multiple cases of the uses of local government OG to examine how the interrelations and underlying meanings within the use of local government open geodata (OG) influence engagement in an ODE. The selected cases come from various domains and represent a diverse range of users and contexts. Our approach allows us to comprehensively analyze the local government OG utilization process, identify commonalities and variations, and consider the ODE interrelations that emerge from the interactions of participants and the interdependencies with the ODE components. For this study, we have focused the participants on an ODE with a common interest in utilizing outdoor facilities OG made available through the Danish government initiative previously described (see section 2.1). Table 1 displays the selected use cases in terms of domain and affiliation.

The first case exemplifies local government OG's innovative potential in mobility planning for cycling routes. This initiative, led by a Danish regional government, is developing an approach to connecting the cycling routes of the region's municipalities. The second case shows how local government OG's can shape inclusive sports and recreation policies. It is driven by an association and interest organization representing and supporting municipalities across Denmark. The third case highlights the local government OG's use of nature data in tourism. This initiative, led by a business foundation, is focused on the sustainable growth and development of nature tourism in Denmark (*Bedre vilkår for cykelturismen i Danmark*). The fourth case uses local government OG to promote outdoor recreational activities in nature through an online platform run by the central government through the Danish Nature Agency. The fifth case is connected to the fourth but focuses on improving nature accessibility for people with disabilities. A non-profit organization coordinates the project, which aims to enrich local government OG on outdoor facilities in nature. The sixth case utilizes local government OG to streamline services for dog owners. A lay citizen and dog owner runs the initiative. Finally, the seventh case demonstrates how a private consultancy uses local government OG to develop digital solutions for municipalities. The consultancy was also responsible for developing the Danish local government OG data model and focuses on developing solutions to the city's future societal challenges through GIS solutions, climate adaptation, environmental consulting, construction, urban planning, landscape, mobility, and strategy. These cases will be further explained in the results of the study.

4 Findings

In this section, we present the results from the cross-case analysis of the selected cases based on the theoretical framework of the

Table 1: The table displays the selected cases regarding domain, affiliation, and the roles of interview participants.

Case	Domain	Affiliation	Interview Participants
Case 1	Cycling routes planning	Regional government	Coordination (1)
Case 2	Sports and leisure strategy	Association and interest organization	Strategy (1)
Case 3	Coastal nature tourism	Business foundation	Department head (1), Management (1)
Case 4	Outdoor recreation in nature	Central government	Lead (1)
Case 5	Accessibility to nature	Non-profit organization	Lead (1)
Case 6	Pets' facilities	Lay Citizen and dog owner	Ownership (1)
Case 7	Software development	Private consultancy	Development (1)

interrelations and underlying meanings in using open government data within ODEs (Figure 1). In the next sub-sections, we described the themes identified from analysing the underlying meanings and matter derived from the utilisation of outdoor facilities data made available through the subject-specific dataset of the Danish open government data initiative, as well as the local ODE interrelations involved in the use of the data within the ODE.

4.1 Underlying Meanings and Matter in the Use of Local Government Open Geodata

4.1.1 Solution-driven Meanings. According to the collected data, making local government geodata publicly available can help identify connections and gaps in outdoor infrastructure, making it easier to visualize potential connections and identify areas lacking infrastructure. It facilitates better planning for active travel, coastal nature tourism, and other initiatives. Sharing data can also save time, effort, and resources for different governmental instances and levels by avoiding duplication of efforts and focusing on larger initiatives. Standardizing data models can streamline project development processes and provide a simplified way to access and utilize data for application development.

Opening local government geodata can also attract new user groups and broaden leisure needs beyond physical facilities by facilitating the development of user-friendly systems and data that align with their preferences. The availability of data on green spaces and outdoor recreation can benefit various user groups, including students, elderly people, and those seeking physical or mental health benefits. Furthermore, data-driven apps can enhance user experience by improving accessibility to common goods. Web platforms and apps using the OG provide outdoor information, enabling people, including those with special needs or disabilities, to find good experiences in nature.

The OG utilization also helps municipalities deal with and control organizational differences more easily. Presenting local government OG in one comprehensive package and allowing the development of meaningful systems and data for users, such as sports facilities connected to leisure paths. The local government OG database provides a solid base that people can easily use across different platforms according to their needs and preferences. In that way, citizens' well-being can also be impacted, as it can improve the provision of information about common goods such as nature locations, which in turn can increase well-being and improve the lives of users.

4.1.2 Collaboration-driven Meanings. The local government OG utilization supports collaboration-driven meanings by fostering transparency through open access to infrastructure, recreational facilities, and cycling data. This allows for a better understanding of the current infrastructure state to identify improvement areas. The initiative also encourages municipalities to work together and update their databases to provide a complete picture of various aspects of their localities. By promoting open standards, data can be seamlessly shared across platforms and systems, ensuring interoperability and effective communication between different stakeholders. This can foster collaboration between different organizations and platforms, enhancing services and enriching user experiences.

The local government OG initiative helps break down silo thinking and facilitates cooperation across sectoral, organizational, political, and geographical borders. This enables a more integrated and comprehensive problem-solving approach by breaking down barriers between different areas of focus, such as bike infrastructure, outdoor facilities, mobility, and leisure activities. Planners and decision-makers can comprehensively view available resources, infrastructure gaps, and locality needs by considering multiple layers of information when making important decisions. The initiative provides the foundation for strengthening partnerships and promoting good governance by fostering accountability and trust among stakeholders.

The OG availability and utilization also promote dialogue between municipalities and citizens by providing a platform for data exchange and collaboration. For instance, local officials register and share data in cases five and four, making citizens aware of outdoor possibilities. Citizens could then contact local government officials and request specific data to be added to the database. This dialogue helps create awareness among different stakeholders and fosters a sense of community engagement. The initiative also serves as a foundation for people to make informed decisions and contribute to developing their localities. It promotes accountability and public participation by encouraging citizen feedback.

4.1.3 Knowledge-driven Meanings. The OG initiative helps local governments understand the needs of their communities and improve public services, particularly in the context of outdoor activities. By promoting a more user-centric perspective, where decisions are based on the needs and preferences of local communities, the initiative encourages a shift towards more effective and efficient service provision. The initiative provides local governments with comprehensive and accessible data that can be used to identify areas lacking infrastructure for activities like cycling, hiking, or walking

with pets. By integrating different data layers into the planning system, they can make informed decisions considering the needs and interests of different people and organizations. Additionally, by combining OG data with other relevant factors like population demographics or activities, local governments can gain insights into the specific needs of local populations. For example, in case two, sports and leisure strategy, this approach enabled them to learn about the interests of different age groups.

Open and accessible data benefits local governments, regional governments, neighboring municipalities, local businesses, and individuals who can use it to inform decisions. Policymakers can assess potential consequences and impacts on different domains of their decisions, including mobility, environment, economy, and social factors. Furthermore, this approach enables discussions about sustainable development by providing valuable information that can be used to address societal challenges related to the environment and sustainability issues. For example, in the case of cycling route planning, it was mentioned that understanding where people need to go can help in planning routes to lower the need for transportation by car.

The initiative also promotes the involvement of diverse groups of users. It facilitates the collection and sharing of accessible information to everyone and provides end-users with information to make decisions. For example, open data provides users with information about facilities, pathways, and other relevant details in the context of outdoor recreation and nature availability. By involving diverse communities in the data development process, the voices of these communities can be included in the decision-making processes, aiding in the self-determination processes of these communities. This involvement process can also increase knowledge sharing within different local communities and help identify barriers and gaps in services, allowing for targeted interventions to address inequalities.

4.1.4 Material Embodiments. In the context of the open government initiative in focus, the matter or material embodiments in the use of local government OG often takes the form of analytical queries, reporting, geographic representations, visualizations, integrated databases, or digital data-based applications. Analytical queries based on data about infrastructure and facilities can help users perform tasks such as identifying connections and gaps or assessing costs. The same data can also be transformed into reporting, providing the basis for informing users about the status of their projects. For instance, in case four, one of the funding organizations developed a report on local government OG availability by ranking municipalities according to their data publication status. This helped create awareness across municipalities and encouraged them to continue or improve the publication of outdoor facilities data in nature.

Furthermore, the geographic representations and visualizations of mapping areas where infrastructure needs to be built or improved or providing navigation systems on route planning for users such as hikers or cyclists are also outputs that were mentioned. To enable these, an important and bridging material embodiment is integrated data, connecting different data infrastructures and databases with different types of data, such as cycling data with highways or bus stations. Finally, the integrated data are the basis for building digital data-based applications like apps and web platforms to provide

information on facilities, such as shelters, water sources, and parking. This allows end-users such as tourists or cyclists to access and utilize data.

4.2 Interrelations in the Use of Local Government Open Geodata

4.2.1 Operational Interrelations. The importance of identifying data needs, data validation, and data collection to ensure the relevance and accuracy of the datasets emerged as an important theme in cases one, three, and six. In case one, data was used to identify the connectivity needs of cycling infrastructure in the region and conduct field registrations in a region in Denmark. The data collected shows the significance of connecting activities and assessing existing infrastructure using data, such as orthophotographs provided by the central government's OG initiative, to identify new data needs municipalities can provide through the local government OG system. Case three on coastal nature tourism underscores the importance of validating data to create comprehensive and accurate digital cycling networks. The process involves giving municipalities access to the mapping based on data and requesting them to ensure that specific parameters are updated within the local government OG. In the case of pet facilities (case six), relevant data was found through an online browser, and the local government OG initiative was contacted for assistance. The platform's complexity made the process difficult and required extensive support, emphasizing that the OG initiative website platform needs improvements to be user-friendly and logical.

The interviewees in cases one, four, and seven mentioned the importance of ensuring data quality and management to foster trust and reliability in the datasets. Standardized naming conventions and terminology are necessary for consistent labeling of data across different municipalities and regions. A system for quality checks and verification of collected data is also crucial in ensuring accuracy and reliability. According to the data gathered, consistent data quality requires standardization, verification, collaboration, and integration of user feedback. Data availability and management include ensuring that data is accessible and up-to-date, collaborating with different departments and stakeholders to gather and maintain data, continuously improving the quality of data through user feedback and updates, planning and organizing data work on an annual basis, integrating data from various sources into a centralized database, promoting the use of open data by encouraging other municipalities to contribute with their data to the OG initiative as a common platform, regularly documenting and analyzing data for decision-making purposes, coordinating technical aspects and functionalities of data-driven platforms, and providing support and resources to facilitate self-help and enable end-users to utilize and navigate the data effectively. Finally, the relevance of standardizing data across different municipalities and regions was discussed to ensure that data is comparable and consistent. A system for quality checks and verification of collected data is necessary to ensure its accuracy and reliability. In all cases, the collaboration between municipalities was recognized by the interviewees as contributing to data management in aspects such as ensuring data consistency and interpretation and data quality maintenance.

4.2.2 Technological Interrelations. In all cases, the interviewees highlighted the importance of having a robust technical infrastructure to manage local government OG efficiently. Such infrastructure must enable collecting, storing, integrating, processing, analyzing, visualizing, sharing, and collaborating with data. All the necessary technological tools, capabilities, and resources must be available to achieve this. The need for the local government OG initiative system to seamlessly integrate with existing tools and databases was also mentioned, emphasizing interoperability as a precondition for efficient data utilization. While specific technological tools were not explicitly mentioned, concepts such as open data systems, APIs, and centralized repositories are recognized as crucial in achieving these goals. The infrastructure should support collaborative features that allow multiple stakeholders to contribute, share, and work together on data. The technical infrastructure should facilitate data sharing through APIs, web services, and standardized data formats to enable seamless integration with other systems and platforms. For example, cases two and seven mentioned APIs to connect different systems and enable data transmission as they facilitate the exchange of data between applications and platforms. In case three, the relevance of utilizing and integrating data from existing systems is mentioned. By leveraging established databases and repositories, organizations can avoid duplicating efforts and ensure that comprehensive and up-to-date data is available.

In all cases, the interviewees advocate for centralized data storage to eliminate redundancy, improve quality, and provide a unified platform for collaboration, data sharing, integration, and accessibility across different platforms. According to them, the local government OG system serves as a home for various types of data and enables open sharing to foster collaborative environments for data utilization and avoid data silos. It allows municipalities to provide input based on local knowledge and validate data on outdoor facilities. By connecting different data sources and making them accessible through a single interface, end-users could easily access and utilize relevant information without needing multiple logins or complex data transfers. The Danish environmental portal was mentioned as an example of a platform used to address overall societal problems with the collaboration of different sectors. User-friendly interfaces and user input were emphasized, along with the importance of designing systems that cater to users' needs and capabilities. The local government OG initiative efforts to create a user-friendly platform for planning and managing outdoor facilities were recognized. According to the data gathered, simplifying the process of entering and updating data is important to encourage user participation. For example, features in the local government OG system allow municipalities to transfer existing data from their databases to the initiative database, minimizing the effort required for validation and maintenance. The interviews mentioned that it is essential to place the data within existing data systems like the local government OG system and create an infrastructure to connect user-generated data, such as feedback and input from cyclists or tourists, to help design systems that cater to their needs. OpenStreetMap was mentioned as an example of a platform that enables users to contribute and update geodata, ensuring that the information reflects the real-world experiences and preferences of end-users. The interviewees mentioned that by incorporating

user-generated data, simplifying data entry processes, and integrating with existing systems, this technology can ensure that the resulting systems are user-friendly, efficient, and tailored to the specific requirements of end-users.

4.2.3 Strategic Interrelations. The themes emerging from the analysis of the strategic interrelations include shared vision setting and data integration, user-centricity, resource allocation and sustainability, awareness creation, and societal relevance. Encouraging collaboration through setting a shared vision is crucial to breaking down siloed thinking between different departments or organizations involved in data collection and management. To achieve that, establishing common standards and protocols for data collection and naming conventions is required to reduce duplication efforts and enhance the overall quality of local government OG. Quality checks are also necessary to ensure the reliability of the collected data. Prioritizing the needs of users when creating open data-driven platforms is crucial to ensure they are intuitive, relevant, and effectively utilized. To ensure that the collected data is relevant, impactful, and aligned, it is essential to take users seriously when they use open-data-driven platforms. Regularly evaluating the data's relevance and effectiveness in addressing societal needs and soliciting feedback from users and stakeholders is necessary. Engaging with end-users is also important to understand their needs and ensure the collected data aligns with societal priorities.

Cases one, three, four, and five reveal the significance of having sufficient resources and long-term sustainability planning for open data-driven projects using local government OG. Sustainable funding, workforce, and infrastructure are essential to maintain such initiatives beyond the initial project phases. Governments can allocate budgets and grants to support various data-related projects and initiatives, such as case one, run by a regional government, or case two, run by an association and interest organization that represents and supports the municipalities across Denmark that have voluntarily decided to participate in the association. An organizational culture around opening data should be fostered to improve the OG's sustainability. Local government officials require technological and strategic tools to prioritize tasks and engage their colleagues and bosses. Financing resources through government funding is one of the primary strategies for prioritizing local government OG. However, it is crucial to consider a combination of approaches to secure the necessary financial resources based on the project's specific context and objectives.

5 Discussion

The mutual interdependencies within the ODE surrounding local government OG influence participants' engagement in its use. After analyzing the interrelations, underlying meanings, and material embodiments in utilizing local government OG, we used a cross-case analysis approach to gather data from seven use cases. We observed that some emergent themes concerning the ODE interrelations not included in the original framework, such as *accountability*, *regulatory*, *functional*, and *ethical* interrelations, also influence engagement in using the local government OG.

By studying the *strategic* interrelations of ODEs, we can understand how participants deal with long-term and outward-oriented












Use Purposes		Use Interrelations		
 Solution-driven meanings	 Material embodiments	(1) Obtain	(2) Transform	(3) Sustain
		<ul style="list-style-type: none">• Identify data needs• Prioritise data• Allocate resources• Collect data• Standardise data• Validate and verify	<ul style="list-style-type: none">• Project Definition• Connect and partner• Project Alignment• Access• Uptake• Visualisation	<ul style="list-style-type: none">• Showcase availability• Secure resources• Encourage users contributions• Monitor• Update
 Collaboration-driven meanings		 Operational		
		 Technological		
 Knowledge-driven meanings		 Strategic		
		 Functional		
		 Accountability		
		 Regulatory		
		 Ethical		

Figure 2: Iterated version of the framework of the interrelations involved in using open government data, and its underlying purposes within ODEs

dynamics when utilizing local government OG. This includes aspects such as shared vision setting, data integration planning, resource allocation, strategic sustainability, and awareness creation. However, some factors are also related to how organizations handle the long-term inward-related dynamics that focus on stability, continuity, and the establishment of agreements to utilize local government OG. These aspects can be observed by analyzing *accountability* interrelations such as responsibility and ownership, collaboration and partnership agreements, quality control measures or procedures, and transparency agreements. Furthermore, other interrelations that are also long-term and outward-oriented interrelations require a focus on how to deal with laws, rules, and policies related to the local government OG; these can be observed by analyzing *regulatory* interrelations influencing the dynamics of the participants.

Understanding the *functional* interrelations is relevant for participants, as it helps them grasp the benefits and best practices of using local government OG. It's crucial to comprehend the abilities and capacities of individuals, organizations, systems, or entities to effectively perform specific tasks or functions in the ODE. In our analysis, we also found common themes around the tension between data ownership and collaboration, as well as the need for data management practices to ensure data privacy, responsible data use, and inclusivity as opposed to implementing user-centricity. Additionally, making local government OG available to the public is seen as a societal task where local governments are responsible for directing the value generated for the public interest and benefit. Therefore, *ethical* interrelations among ODE participants are essential to analyse these tensions and ensure societal relevance in using local government OG.

During the analysis, it was also observed that the ODE interrelations differ depending on the project's development stage and the expected objectives according to the data utilization process. These objectives can be categorized into three main groups as they are related to 1) *obtain*, 2) *transform*, and 3) *sustain* OG use. The *obtain* stage considers the achievement of objectives such as identifying data needs, prioritizing data availability, allocating resources, and collecting, standardizing, and validating data. The *transform* stage considers goals such as project definition, connecting and partnering, project alignment, access, uptake, and data visualization. The *sustain* stage considers goals such as showcasing availability, securing resources, encouraging users' contributions, and monitoring and updating the data.

Finally, by examining the different aspects of the interrelations within the ODE, we can gain insights into the various roles that participants in the ODE might take on when using local government OG. These roles may include *operational* aspects such as data ownership, data analysis, or data standardization experts; *strategic* roles such as business analysts, leaders, or conveners; *technological* aspects such as platform developers, system administrators, or GIS specialists; *accountability* roles such as project managers or coordinators; *regulatory* roles such as auditors or compliance officers; *functional* roles such as facilitators, coordinators, communicators, or assistance; and *ethical* roles such as users, volunteers, decision-makers, and end-beneficiaries. Using the themes identified during the cross-analysis process, the framework for understanding the interactions in the use of local government OG was updated, and new dimensions of the ODE interrelations were incorporated. The revised framework is depicted in Figure 2.

6 Conclusion

This study empirically examined the use of local government OG and how the interrelations and underlying meanings within the use of local government OG influence engagement in an ODE. The study focused on the data of users of outdoor facilities available through a subject-specific dataset of a Danish local government OG initiative. The research found that *operational, technological, strategic, accountability, regulatory, functional, and ethical* interrelations can influence the engagement of ODE participants in utilizing local government OG for creating solutions, knowledge, or collaboration. These interrelations can help understand the roles emerging during the process of local government OG utilization, which may change according to the objectives of OG utilization stages and can be categorized into 1) *obtain*, 2) *transform*, and 3) *sustain* OG use. Further research is necessary to determine the roles and their influence during the different stages of OG utilization. Based on the findings, an updated framework of the interrelations involved in using local government OG, and its underlying purposes within ODE is presented. The categorization of the themes in the framework can support policymakers, practitioners, and researchers in evaluating and monitoring local government open data use and adopting an ecosystem approach, while the empirical results exemplify the practical implementation of the concepts. By utilizing the framework as an analytical tool, it is hypothesized that it is possible to identify the challenges of ODE participants to engage in ODEs and support the design and implementation of strategies to enhance the impact of local governments' open data initiatives in achieving the intended purposes within ODEs by adapting strategies to the different stages of open government utilization. Further research is needed to explore whether using the theoretical framework can serve as an analytical tool.

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