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Towards a More Resilient Ecosystem: Case Study of Open Government Data in Taiwan

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Abstract

The significance of resilience, an attribute that remains underexplored within the context of open data, holds immense potential for shaping long-term advantage in the sustainability. This research aims to underscore the importance of incorporating resilience considerations in the establishment and sustenance of ecosystems specifically designed to foster open government data. Through a case study conducted in Taiwan, this paper showcases the integration of an ecosystem and platform model, facilitating a more resilient and sustainable Open Government Data (OGD) system, particularly attuned to adaptative responses in the face of systemic shocks and crises. This paper emphasizes the critical role of a supportive ecosystem, a well-designed open data platform, and a user-friendly interface in realizing the full potential of open government data and open data initiatives. These interconnected factors necessitate careful consideration and strategic development to achieve successful outcomes. By (1) presenting a case study of Taiwan to exemplify the fusion of OGD ecosystem and platform models, and (2) offering insights into the design of an OGD ecosystem from a resilience perspective, this paper contributes to the existing literature. This holistic approach allows for the integration of diverse perspectives, stakeholders, and knowledge sources, fostering resilience and adaptability within the OGD landscape.

Keywords: Resilience; Ecosystem; Platform; Open Government Data

1. Research Background

Open Government Data (OGD) is a form of innovation that emerges from the delivery of new government services via information technology platforms. Building the OGD as an ecosystem that promotes the adoption of OGD by government agencies from a resilience perspective can offer valuable insights into the challenges associated with major disruptions caused by pandemics and other external shocks. Since the service sector evolved with the rise of well-known platforms such as Uber and Airbnb (Geissinger et al., 2020), establishing a new economic format based on a collaborative model that connects service providers with customers through a platform. In this model, the platform owner only serves as a facilitator of connections and does not own the products or services offered (Kenney & Zysman, 2016). However, the COVID-19 pandemic has caused significant disruptions for organizations across various industries and sectors around the globe. It has highlighted the crucial need for resilience in dealing with and recovering from major disruptions caused by pandemics and other external shocks. By developing

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resilience, businesses and individuals can better comprehend the threats they face, identify and address weaknesses, and respond effectively and rapidly to any exploitations. Previous research has examined various factors that impact the adoption of OGD within government agencies (Attard et al., 2015; Chen, 2022; Kucera & Chlapek, 2014; Wang & Shepherd, 2020), but no prior studies have investigated this topic from the perspective of resilience.

OGD is a type of data resulting from the intersection of open data and government data. It refers to large datasets released by governments at no cost for analysis by anyone, accessible to everyone, machine-readable, with no limitations on reuse and redistribution. The development of OGD dates back to 2008 when the US Federal Government first initiated the opening of government data on a large scale. This policy has since expanded to other countries worldwide (Tran & Scholtes, 2015). Open data movements have emerged around the world in recent years, leading to the development and implementation of various open data policies aimed at guiding the publication of government data and maximizing its use (Zuiderwijk & Janssen, 2014a). Numerous OGD portals, including data.gov.uk, data.gov, data.gov.tw, and data.gov.sg, have been established to provide citizens and stakeholders with access to government information from various fields (Attard et al., 2015). The two primary objectives of these initiatives are long-term transparency and data reuse, with the economic benefits of OGD policies also being emphasized (Janssen et al., 2012; Zuiderwijk & Janssen, 2014b). Differences in policies and initiatives can stimulate the provision and use of OGD in unique ways, providing opportunities for learning from one another.

1.1 Problem statement

Public sector bodies hold a significant amount of open data that has the potential for reuse. These bodies are responsible for creating, collecting, and making government data available from various domains (Janssen, 2011). Therefore, the realization of open data and open government highly depends on the support of a healthy legal environment and execution, a well-designed open data platform, and a friendly user interface. The commonly accepted premise underlying these key dimensions is that the publishing of government data in a reusable format can strengthen citizen engagement and yield new innovative businesses. However, as these open government data strategies are relatively new, evidence of the expected impact is still limited. Important questions are currently being debated, such as: What is an appropriate open data strategy for governments to maintain the benefits of transparency and participation? Why are some governments succeeding in adding value to the OGD ecosystem, quickly responding to crises and shocks, and others even struggling to open the data up?

Since the COVID-19 pandemic has acted as both a catalyst and a crucible for OGD, it has accentuated its societal utility and instrumental value, while concurrently exposing areas that require rigorous scholarly and policy attention for its enduring evolution. Whenever more governments around the world are designing and implementing OGD in order to increase transparency, participation, and/or government efficiency. However, little attention has been

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paid to resilience which can provide practical suggestions and guidelines in terms of the establishment, design, and user interfaces of a more sustainable OGD ecosystem for recovering from the crisis and shock. While some case studies have explored national open data policies and initiatives (Janssen & Estevez, 2013), there remains a lack of research examining the design and implementation of OGD as an ecosystem through the lens of resilience. Such an understanding would be valuable in the development of new open data policies and in enhancing existing OGD ecosystems.

Resilience is an essential concept for ensuring psychological or systemic stability during disasters or shocks (Bai et al., 2021; Bristow & Healy, 2020; Bryce et al., 2020; Simmie & Martin, 2010). In the last few decades, resilience has been applied in different contexts and fields, including psychological and emotional development, community action, environment, physics, health and medicine, and learning and teaching (Afifi et al., 2016; Allen et al., 2020; Aquilué et al., 2020; Blanchet, 2015; Folke et al., 2002; Holling, 1973, 1996). Despite this, its application in the digital field is a recent development, and the concept of resilience is still an area of research that has not yet received significant attention in the realm of information systems or information science research.

The central research inquiry guiding this paper is: "What is the significance of integrating resilience considerations into the design and operation of Open Government Data (OGD) ecosystems?" The paper casts a scholarly spotlight on the paradigm of resilience, operationalized within the framework of a Taiwanese case study on OGD. The objective is to delineate and instantiate resilience considerations in the design and stewardship of OGD ecosystems. In essence, resilience pertains to the creation, deployment, and utilization of information systems endowed with rapid recovery or adaptive capabilities during severe disruptions. Taiwan's agile response to the COVID-19 pandemic, characterized by timely, transparent, and accurate information dissemination coupled with culturally nuanced decision-making under conditions of uncertainty and temporal constraints, exemplifies societal resilience and the safeguarding of citizen interests. This scholarly contribution enriches existing literature in two pivotal respects: (1) it proffers a focused case study that elucidates the synergistic integration of OGD ecosystems with platform models in Taiwan; and (2) it unveils the architecture of an OGD ecosystem through the lens of resilience. Within this discourse, the study identifies and differentiates two key platform archetypes—online and offline. Moreover, the paper posits that these archetypes evolve in tandem, reflecting parallel developments in architecture, services, and governance. Consequent to this empirical investigation, the paper advances policy implications and strategic recommendations aimed at fortifying the resilience of OGD ecosystems.

The rest of this paper is structured as follows: Section 2 discusses the related works of resilience, platform, and ecosystem. Section 3 introduces the research design. Section 4 presents the case study of the OGD ecosystem in Taiwan. Section 5 discusses the results and findings, draws conclusions, and outlines future work.

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2. Theoretical Background

2.1 Resilience

The study of resilience has been regarded as very important in ecosystems, however largely ignored in information science (Folke, 2016; Holling, 1973). Contemporary scholars have regarded resilience as a measure of an area's ability to course correct following a technological shock or sudden economic downturn. Resilience effectively encompasses competence to sustain of trending decline brought on by calamitous, destructive events or downturns while maintaining innovative capacity (Balland et al., 2015). Definitions of resilience have evolved over time, but at its core, resilience refers to the ability to positively adapt and maintain or regain mental health despite experiencing adversity. The sources of resilience, including personal, biological, environmental, and systemic factors, and their interactions, are considered (Davidson, 2010; Magis, 2010; Watanabe et al., 2004).

Resilience, a multifaceted construct, pivots on five essential pillars: networks, institutions, interactions, adaptation, and diversity. Each plays a role of indispensable import in configuring an organization's resilience quotient. Firstly, networks act as critical conduits for the flow of knowledge and innovation, forging relationships predicated on mutual trust. They empower not just isolated entities but entire ecosystems to exhibit resilience by way of cooperative problem-solving and adaptive learning (Christopherson et al., 2010; Nooteboom & Gilsing, 2004; Pike et al., 2010). Secondly, institutions serve as formidable bastions in fostering conditions conducive to collective social and economic upliftment. Their robustness directly correlates with an entity's resilience and productivity, validated by extensive scholarly work (Afonso, 2016; Balland et al., 2015; Simmie & Martin, 2010). Thirdly, the centrality of interactions within the resilience matrix cannot be overstated. They illuminate the synchronized choreography of multiple stakeholders, each contributing to the generation, facilitation, or dissemination of innovation. The density and quality of these interactions enhance the adaptive capacity of the ecosystem, enabling effective responses to external shocks or shifts. Fourthly, the principle of adaptation signifies a system's fluidity in realigning its internal architecture to harmonize with external exigencies (Christopherson et al., 2010). The epitome of resilience here lies in an organization's agility to undergo transformations while preserving its essential functions and performance metrics (Walker et al., 2004).

Lastly, the notion of diversity transcends mere terminological rhetoric to attain practical significance. An organization's resilience can be seriously jeopardized by over-commitment to a singular sector or industry. Here, diversification emerges as a tactical lever for enhancing resilience, better equipping organizations to absorb and capitalize on external influences (Balland et al., 2015; Rose & Krausmann, 2013; Simmie & Martin, 2010). Therefore, an organization's ability to bounce back and succeed, even in uncertain times, comes from its skills in five key areas. Each of these areas helps the organization stay strong and flexible, allowing it to turn challenges into chances for long-term growth and change.

The integration of resilience consideration into ecosystem studies offers a holistic understanding of the fundamental dynamics at play and

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contributes to the advancement of this field of research. Resilience theory has traditionally been categorized into two perspectives based on past scholarly interpretations of recovery. The first perspective posits that resilience is the system's ability to return to pre-shock equilibrium trajectories following a disruption. Furthermore, it is crucial to acknowledge that the local, national, and global environments undergo constant change, even in the absence of catastrophic events. The momentum of continuous augmentation does not necessarily diminish, pause, or adapt in alignment with specific ecosystem circumstances. In light of this, scholars have increasingly embraced an evolutionary framework of resilience that recognizes the interconnectedness of territories and acknowledges that they do not exist in isolation. By adopting an evolutionary perspective, researchers can explore how ecosystems interact and evolve within their broader contexts. This approach recognizes the intricate relationships between ecosystems and their dynamic environments, emphasizing that adaptation, learning, and transformation are essential components of resilience. It allows for a more nuanced understanding of how ecosystems respond to disturbances, exploit opportunities, and evolve over time (Balland et al., 2015; Christopherson et al., 2010; Rose, 2004; Swanstrom, 2008). An interactive model of resilience illustrates the factors that enhance or reduce homeostasis or resilience. More accurately, they are quite sensitive to the transitions of outside factors and must be able to adapt to them in order to uphold system output levels over the long-term (Simmie & Martin, 2010).

2.2 Open government data

Discussions and debates of OGD have become widespread in practice and academic literatures on contemporary governments (Lathrop & Ruma, 2010; Pizzicannella, 2010; Stephenson, 2009). There have been four major research streams summarized for OGD issues: the implementation and evaluation of policies and initiatives, characteristics of data and the design of data portals, the driving forces and factors influencing open data environment, and the economic perspectives towards the value creation of open data. Existing studies have been performed to compare open data policies in a systemic and structural way (Attard et al., 2015; Huijboom & van den Broek, 2011; Rothenberg, 2012). There have been several motivations and expected benefits observed from OGD policy, such as: increased transparency, improved public relations and positive attitudes toward the government, increased reputation of the public sector bodies, transparent way of informing the general public about the governmental policies, improved government services, government data and processes, increased value of the data (Janssen et al., 2012). Increased transparency in the public sector can improve the availability and accessibility of data related to government performance, such as budgetary or public contracts data. This allows stakeholders to access, reuse and distribute the data, enabling the government to inform citizens about its policies, plans, and performance evaluations. This can help build trust, understanding, and a positive attitude towards the public sector, and allow citizens to actively participate in governance processes. However, the extent of openness of OGD is still limited,

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and efforts are being made to improve it (Wang & Shepherd, 2020).

Open data are expected to induce an open government in which the government acts as an open system and interacts with its environment (Janssen et al., 2012). Besides the benefits and barriers of OGD implementation, there are also possible risks identified, including trade secrets, privacy infringement, misinterpretation of the data, the risk to the security of the infrastructure, and so on (Kucera & Chlapek, 2014). There is an interesting observation that whereas the driving forces lie predominantly outside the government, such as: citizen pressure, market initiatives, emerging technologies and the ideas of thought leaders, the barriers are usually within government organizations (Huijboom & van den Broek, 2011). This barrier is derived from public organizational behavior as well as traditional separation between public organizations and users (Janssen et al., 2012).

2.3 Technology-push vs. demand-pull

The approach of technology-push is based on the linear innovation model and aims to generate a competitive edge and fresh value proposition (Di Stefano et al., 2012). The objective of technology-push strategies is to develop products and services that meet the needs of customers and end-users, even if there is no explicit demand for the underlying technologies. Technology-push strategies rely on various approaches, such as: research and development investments, university-industry collaborations, and technology brokers who facilitate the transfer of technology from research organizations to companies. Bringing new technologies to the market requires evaluating their feasibility and maturity through testing, investing in their diffusion, and devising strategies to encourage their adoption. In contrast, the demand-pull approach is driven by consumers, end-users, or other individuals or groups expressing their needs and demands for new technologies (Isoherranen & Kess, 2011). This approach is triggered by unsatisfied customers who create new demands, leading to the need for problem-solving to meet customer and end-user satisfaction (Brem & Voigt, 2009).

Value creation in the OGD ecosystem is primarily driven by two factors: (1) technology-push, which focuses on increasing the supply of data options by promoting development in OGD, and (2) demand-pull, which stimulates demand for goods or services derived from OGD. However, simply raising awareness is inadequate for achieving sustained adoption and usage of OGD. It is essential to design the core interaction of the OGD ecosystem in an appealing way to naturally attract users. In recent years, the balance between demand-pull and technology-push policies at the policy level has shifted strongly towards demand-pull (Hoppmann, 2015). There have been different demand-pull policy instruments developed for a long time, and resulted in differences in how strongly they foster innovation (Girod et al., 2017). Furthermore, the costs of implementing demand-pull policies will be decreased, if technology investors are allowed to develop multiple applications (Stephan et al., 2016). Therefore, the adjustment for the design of demand-pull policies is very much needed to be calibrated with technological and market dynamics (Hoppmann et al., 2014). Sectoral configuration in the balance of technology-push and demand-pull policy instruments over the different stages of the

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OGD development should be taken into account for establishing a sustainable ecosystem (Stephan et al., 2017).

2.4 Platform vs. ecosystem

Platforms act as intermediaries between different groups and enable the development of complementary modules by third parties, leading to the emergence of ecosystems around these platforms. With the increasing digitization of industries, platform business models are becoming feasible in more domains. Platforms offer an architecture for other firms to use as an interface in developing their own complementary components and enable transactions between extensive networks of users. The success of platforms depends on a clear alignment of incentives among the platform company, third-party developers, and end-users, which varies based on business model decisions on how to monetize the platform. Scholars in economics mainly concentrate on network effects that boost the value of the platform (Koh & Fichman, 2014; Song et al., 2018; Tanriverdi & Lee, 2008). Technology management experts examine how a technological architecture attracts actors in the platform (Chae, 2019; Den Hartigh et al., 2016; McIntyre & Srinivasan, 2017; Meyer & Lehnerd, 1997). Operations management researchers are focused on comprehending how platforms align the demand and supply from independent service providers in the sharing economy (Parente et al., 2018). Additionally, some researchers investigate how operations within a company adapt to platforms (Cenamor et al., 2017). This study articulates that the functional scope of a digital ecosystem is notably augmented through the orchestrated integration of third-party complementary products within the core platform architecture (Cusumano, 2002; Eisenmann et al., 2006; Parker & van Alstyne, 2005). Within this intricate digital ecosystem, three constituent elements emerge as salient: a foundational primary platform, a diverse array of complementary products, and a plethora of boundary resources that serve as conduits for interfacing between the platform and its complementary extensions. Among these boundary resources, Application Programming Interfaces (APIs) stand out as indispensable assets. They empower third-party developers to engineer specialized complementary products that seamlessly coalesce with the primary platform (Ghazawneh & Henfridsson, 2013). The criticality of APIs is accentuated in their role as enablers for the development of innovative digital add-ons, often through the integration of multiple APIs.

Recent academic research on platforms and ecosystems has been growing, but these areas are often studied separately, leading to incomplete understanding (McIntyre & Srinivasan, 2017). To conceptualize value creation within an ecosystem, this study invokes the seminal framework by Moran and Ghoshal (1996), predicated on Schumpeter (1911/1934). This framework bifurcates value into two distinct processes: value creation through resource exchange and combination, and value realization. The mechanism of exchange underpinned by diversity emerges as an instrumental driver of value creation within an ecosystem (Moran & Ghoshal, 1996). Existing research tends to focus more on the technical aspects of platforms and overlooks the social elements, leading to an incomplete understanding of how different factors are interconnected and important for the development

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of ecosystems (de Reuver et al., 2018; Rolland et al., 2018; Tiwana et al., 2010). To fill this gap, this study argues that a more comprehensive approach, which combines both platform and ecosystem views, is essential for a well-rounded understanding of OGD. Such a holistic approach would enrich our understanding of the complex factors shaping innovation within ecosystems, thereby affording a more robust analytical lens through which to interpret the symbiotic relationship between platforms and ecosystems.

3. Research Method

In an effort to fill the scholarly vacuum concerning Open Government Data ecosystems, this study employs a singular, yet rigorous, case study methodology focused on Taiwan—a nation distinguished by its top ranking in the 2018 Global Open Data Index, and by its resilient OGD infrastructure capable of weathering a myriad of societal and exogenous shocks. The complexity and contextually-rich nature of the OGD ecosystem make the case study methodology exceptionally well-suited for delving into the critical construct of resilience as a determinant of OGD sustainability.

The primary objective of this inquiry is to examine the OGD ecosystem in Taiwan, particularly in the context of significant societal upheavals, such as pandemics and political instability. The study aims to illuminate the intricate interplay between resilience-oriented strategies, the technology-push and market-pull dynamics within disparate platform models. Data are scrupulously collected from two pivotal platforms: the government-administered online DATA.GOV.TW and the privately-managed offline Government Publications Bookstore. The selection of these platforms is justified based on their complementary roles in reinforcing Taiwan's OGD infrastructure.

The analytic paradigm employed is a triangulation methodology, incorporating three distinct but complementary approaches: content analysis for decoding the structural and governance underpinnings, comparative analysis for contrasting the online and offline platforms' contributions to resilience, and thematic analysis anchored in extant resilience literature to distill key resilience-fostering attributes and strategies. The culmination of these analysis is the formulation of policy prescriptions designed to fortify OGD ecosystem resilience. These recommendations are empirically grounded and theoretically anchored in resilience scholarship. Thus, the study offers an academically rigorous framework for understanding how resilience attributes can be strategically integrated into OGD ecosystems, thereby enhancing their ability to confront and adapt to multifaceted societal challenges.

4. Case Study

4.1 The evolution of open government data in Taiwan

In a concerted effort to advance transparency, citizen engagement, and democratic governance, Taiwan has enacted a series of legislative and policy initiatives pertaining to Open Government Data and data protection. The foundational legislation for this agenda was set in motion in 2005 with the "Freedom of Government Information Law." Grounded in a commitment to active, timely dissemination of government

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information, the law served to fortify citizens' right to knowledge while promoting democratic participation and engendering trust in public affairs ("Taiwan Open Government National Action Plan 2021-2024," 2021).

The formal inauguration of Taiwan's government open data initiative took place in November 2012. This watershed moment marked a paradigmatic shift towards harnessing collective intelligence for the dual aims of enhancing governmental transparency and elevating the quality of public services. To operationalize this vision, an inter-ministerial OGD platform was unveiled in April 2013. The platform committed to offering data that was free, irrevocable, and vested with open authorization, thereby spurring value-added public applications. This coordinated effort between public and private stakeholders received global recognition when Taiwan secured the top spot in Open Knowledge International's Global Open Data Index in 2015 and again in 2016–2017 (Chen, 2022; Open Government Forum, 2021; "Taiwan Open Government National Action Plan 2021-2024," 2021; Yang et al., 2013).

Furthermore, in a pioneering move for Asian cities, the six municipalities of Taipei, New Taipei, Taoyuan, Taichung, Tainan, and Kaohsiung subscribed to an open data charter in 2018. By November 2020, the national OGD platform had disseminated over 47,000 datasets. Parallel to these OGD advancements, Taiwan has also been vigilant in safeguarding personal data. Originating in 1995 with the Computer-processed Personal Data Protection Act, Taiwan's data protection legislation underwent a substantive amendment in 2010, culminating in the Personal Data Protection Act (PDPA). The legislative scope expanded to encompass both computer-processed and non-computer-processed personal data. In response to the European Union's 2018 General Data Protection Regulation (GDPR), Taiwan instituted a Personal Data Protection Office to coordinate GDPR compliance across government agencies. Thus, Taiwan's multifaceted approach to OGD and data protection encapsulates a comprehensive, evolving policy landscape that effectively balances openness, innovation, and privacy (Chen, 2022; Open Government Forum, 2021; "Taiwan Open Government National Action Plan 2021-2024," 2021; Yang et al., 2013).

In the span of the last decade, Taiwan has demonstrated a noteworthy commitment to advancing its OGD ecosystem. A temporal analysis reveals a strategic layering of initiatives and policies, each calibrated to address specific facets of OGD, such as transparency, accountability, and usability. National Development Council (NDC) spearheading the Taiwan Open Data Portal, a seminal platform offering diverse categories of government data from economic metrics to environmental indicators. These policies served as normative frameworks, mandating government agencies to disseminate data in a standardized, timely fashion and, crucially, via APIs. This regulatory scaffolding was further solidified in September 2013 with the establishment of the Open Government Data Alliance, a multi-stakeholder consortium including governmental entities, academic institutions, civil society organizations, and the commercial sector. In an innovative move, the NDC inaugurated the Open Data Certification Program in 2015, aimed at enhancing data quality through stringent evaluations against predetermined criteria such

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as accuracy, completeness, and accessibility. This institutional mechanism added an evaluative layer to the OGD ecosystem, ensuring datasets met a baseline quality standard. Taiwan's evolution in the OGD domain is not an ad hoc assembly of initiatives but a well-orchestrated, multi-year strategy. Through layered policy formulation, platform development, stakeholder engagement, and quality assurance mechanisms, Taiwan has constructively navigated the complex landscape of OGD, thus emerging as a global exemplar in this critical arena (Open Government Forum, 2021; Ou & Yang, 2016).

Post the institutionalization of the Freedom of Government Information Law, the Administrative Procedure Act, and other correlative legislative instruments, Taiwan has achieved noteworthy milestones in systematizing the governance of public information. These efforts have precipitated Taiwan's ascendance as a prominent democratic nation, particularly in the arena of informational freedom. Recently, there has been an intensifying focus on OGD within the country, a sphere managed by key governmental agencies that have become instrumental in shaping the OGD landscape. Among them, the Industrial Development Bureau (IDB), a central planner in economic development, functions as both the architect of comprehensive strategies and the nexus between corporate entities and governmental structures. These agencies' indispensable roles signal their cardinal importance in the genesis and sustenance of Taiwan's burgeoning OGD ecosystem (Open Government Forum, 2021).

Empirical findings emanating from Taiwan delineate that specific factors account for approximately 60.4% of the variation in agencies' intent and 54.2% of the variation in agencies' operational behaviors (Yang & Wu, 2016). To enhance inter-agency cooperation, it is advisable to designate a particular governmental unit as a coordinator, tasked with mobilizing resources across organizational silos. Addressing apprehensions around data misuse should also be prioritized, as it stands identified as a significant constraint impeding collaborative initiatives. Additionally, assorted research frameworks have been devised to scrutinize the socio-technical determinants that could influence the intentions and actions of governmental bodies in the realm of open data dissemination (Yang & Wu, 2016). Moreover, Taiwan's execution of OGD underscores the salience of digital accessibility, uniform and reusable data formats, and licenses that encourage data repurposing.

This study presents a conceptual framework highlighting the integral relationship among three key elements: A structured stakeholder ecosystem, a strategically designed open data platform, and a user-centric interface. Together, these components are pivotal in harnessing the full transformative potential of Open Government Data initiatives. When it comes to data collection, the judicious use of both offline and online platforms offers a holistic understanding of market demand—offline avenues being potent for targeting specialized demographics, while online strategies offer expansive outreach and behavioral insights. As OGD ecosystems evolve, their proficiency in "matchmaking"—connecting potential users with relevant value propositions—grows increasingly refined. However, a mature OGD ecosystem must transcend mere matchmaking to catalyze value-generating exchanges between third-party content

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producers and end-users. These interactions usually operate within a defined regulatory environment, aimed at fostering value creation via facilitated transactions.

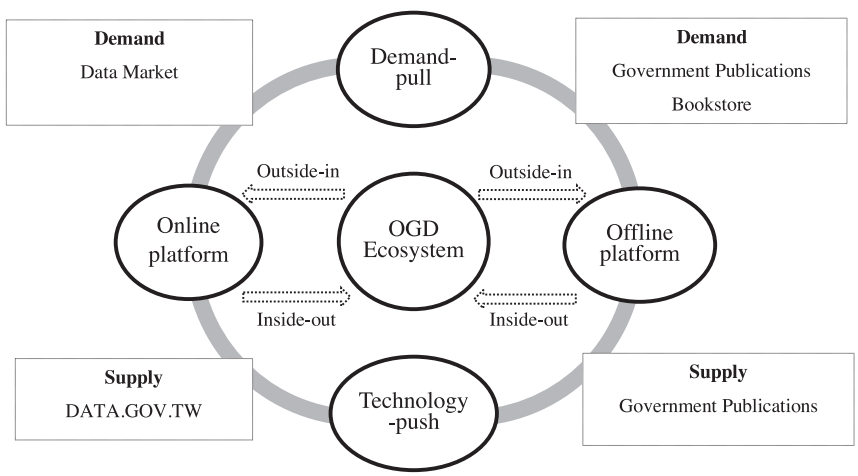
From resilience perspective within this framework, two salient variables, adaptation and diversity, emerge as critical for the ecosystem's long-term sustainability. Adaptation functions as a dynamic lever for iterative refinement, enabling the ecosystem to evolve responsively. Diversity enriches the ecosystem by widening the spectrum of potential value-generating interactions. Institutions within this ecosystem play a dual role: they not only enhance stakeholder interactions, but also fortify ecosystem resilience. It is crucial to highlight that the role of these institutions extends beyond mere resilience-building; they are also agents for co-evolution, tasked with inciting necessary adaptations and cultivating diversity. Consequently, these institutions are integral in sculpting an OGD ecosystem that is both agile and robust, capable of evolving in a complex, ever-changing landscape.

4.2 User-interface strategy: Online and offline platforms

The orchestration of Taiwan's OGD ecosystem represents a multi-faceted endeavour that fuses technology-push factors with demand-pull dynamics, supplemented by a highly strategic user interface design aimed at enhancing citizen experience. The user interface acts as a critical lever for amplifying citizen satisfaction, and serves as a two-way channel for optimizing the utility of the OGD environment. In crafting its public services, the Taiwanese government emulates the private sector's customer satisfaction benchmarks, emphasizing efficiency, transparency, and accessibility. This user-interface strategy is not merely reactive but rather anticipatory, tailored meticulously to meet and streamline both online and offline user interactions.

This cohesive approach aligns symbiotically with dual innovation paradigms of "outside-in" and "inside-out," which were initially conceptualized by Dahlander and Gann (2010). The "outside-in" strategy taps into external

Figure 1. OGD Ecosystem in Taiwan



innovations, while the "inside-out" approach provides an infrastructure for external actors to capitalize on the government's internal expertise and knowledge. Both paradigms are guided by the overarching belief that value creation and organizational proficiency are crucial for the efficacious deployment of OGD initiatives—a perspective that finds resonance in Chiaroni et al. (2011)'s seminal work.

Launched in 2013, Taiwan's keystone platform, DATA.GOV.TW, is complemented by its offline counterpart, the Government Publications Bookstore, established in 2008. Working synergistically, these platforms bolster interactive communication, facilitating engagement with a growing user base. They serve as indispensable assets in catalyzing innovation commercialization, fostering user involvement, and forming strategic collaborations across multiple stakeholders, thereby enriching downstream value chain activities.

4.2.1 Online platform

The inception of Taiwan's Open Data Portal dates back to September 2011, catalyzed by the Taiwanese government's acknowledgment of the pivotal role that open data plays in fostering transparency, fueling innovation, and stimulating economic growth. A specialized entity, the NDC, was established to govern this ambitious project. The NDC collaborated with multiple governmental departments to meticulously select and prioritize datasets to be made public. Concurrently, they crafted a rigorous set of guidelines and standards aimed at guaranteeing the data's veracity, timeliness, and machine readability. The portal was formally unveiled in 2013, initially featuring an extensive collection of more than 60,000 datasets across 16 governmental agencies. The platform was engineered to include multiple utilities, such as a search engine, data visualization instruments, and an API for developer access. In subsequent years, the government relentlessly augmented the portal, adding fresh datasets and enhancing functionalities. Initiatives were also set in motion to galvanize public engagement through hackathons and other interactive events to exploit the power of open data (Open Government Forum, 2021).

Fast-forward to 2018, the portal underwent a comprehensive redesign aimed at elevating the user experience and simplifying data discovery. The revamped interface now includes a more user-centric search function, advanced data visualization capabilities, and heightened accessibility for individuals with disabilities. The platform continues its evolutionary trajectory, with sustained endeavors aimed at enhancing data quality and usability, whilst catalyzing wider societal engagement for research, innovation, and economic upliftment. This online platform paves the way for seamless creation and management of open services across private and community sectors, spurs the incorporation of cutting-edge technologies, and fosters long-term growth in the data and knowledge economy. Citizens are granted unprecedented access to once-restricted governmental datasets, thereby empowering them to undertake independent analyses for personal insights.

The acquisition of public data for value-added applications faces several challenges, including opaque governmental data repositories hindered by convoluted regulations, a communication gap between public and private sectors stemming from divergent objectives, and the technical complexities of managing large datasets. These issues undermine data utility and discourage

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private-sector engagement. Streamlining data governance through empirical guidance and creating a more transparent framework are imperative for reconciling the conflicting interests of governmental agencies and private-sector stakeholders, thereby enhancing both data utility and integrity (Deng et al., 2018).

4.2.2 Offline platform

The Government Publications Bookstore in Taiwan serves as a multifaceted institution with considerable societal impact. Primarily, it functions as a centralized repository for an array of government publications, spanning from legislation to administrative protocols. This access equips citizens with the essential knowledge to comprehend governmental decisions, as well as their civic rights and duties. Secondly, the institution acts as an archival asset, safeguarding a comprehensive collection of materials that chronicle Taiwan's sociopolitical and economic evolution. This curated repository offers an indispensable resource for scholars, historians, and citizens keen on understanding the multifaceted dimensions of Taiwan's heritage.

Additionally, the bookstore is proactive in fostering civic literacy and public discourse. By disseminating official publications, it ensures that governmental activities are subject to public scrutiny, thereby empowering citizens to hold public officials accountable. The Government Publications Bookstore is an integral Taiwanese institution, functioning not merely as an information clearinghouse, but as a catalyst for civic engagement, historical preservation, and governmental transparency. It holds the unique position of being Taiwan's exclusive purveyor of government publications, offering a sophisticated suite of publishing services that extend beyond mere retail. Among its specialized offerings are Print on Demand (POD) and Book on Demand (BOD) services, which grant citizens unparalleled access to out-of-print or time-sensitive governmental materials. The bookstore further elevates its role as a facilitator of information dissemination through an online platform. This digital interface allows users to read, rent, or purchase e-books augmented with multimedia content. Boasting an expansive inventory over 45,000 publications in Mandarin and an additional 2,086 in foreign languages, the interface addresses a diverse readership. The adoption of POD and BOD technologies is emblematic of the bookstore's consumer-centric approach. While POD employs digital storage to usher in novel distribution channels, BOD recalibrates traditional publishing paradigms, offering end-users a plethora of customized and diversified options. In essence, the Government Publications Bookstore in Taiwan merges exclusivity with innovation, functioning not just as an information repository, but as a versatile service provider attuned to evolving consumer needs and technological advancements.

4.3 From a resilience perspective: Unpacking the open government data ecosystem

The resilience and long-term viability of any ecosystem, natural or engineered, is fundamentally tethered to its inherent diversity—encompassing species, organisms, mutual dependencies, collaboration models, and the circulation of information. This multiplicity serves as an evolutionary strategy to confer a high degree of flexibility and adaptability, vital attributes for surviving in an ever-shifting environmental

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landscape. When extrapolating this principle to the domain of industrial policy and environmental management, the notion of diversity metamorphoses into a tenet that encourages varied cooperative paradigms. Within such an ecosystem, multiple stakeholders, each acclimated to their unique environmental conditions, establish a rich tapestry of interdependencies with other constituent elements.

For the ecosystem to achieve sustained flourishing, it is essential to operate within the bounds of the natural limitations endemic to its immediate environment. Understanding these constraints not only informs the development of more effective policies, but also ensures the resilience of the ecosystem in adapting to new challenges and threats. In sum, a resilient OGD ecosystem is not merely a function of the availability of open data, but also of the diversity and interdependence of its actors and the systems that bind them. It integrates adaptability into its design and is sensitive to local constraints, which collectively contribute to its long-term sustainability.

4.3.1 Institutional proficiency in orchestrating Taiwan's open government data initiatives

Institution capability refers to the level of expertise and ability that a government agency possesses in implementing open data initiatives. According to research, information-sharing activities can be considered as information technology projects. As such, organizations that serve as information providers must have the necessary capability to retrieve and integrate data from information systems that utilize varying platforms, data standards, schemas, and qualities (Fan et al., 2014; Yang & Wu, 2014). Davis (2010) emphasizes the significance of adaptable institutions, suggesting that the progressive transformation of institutions is more important than their quality at any given time. Taiwan's government has been actively promoting e-government since 1989, with initial guidelines introduced in 1999 to enhance government transparency and safeguard civil rights. The Taiwanese government's recognition of the significance of open data and open government was spurred by the global trend towards openness and changes in the country's political climate. Following global demands for transparency, policies related to OGD have been developed. The effective implementation of these policies is driven by facilitative conditions and organizational capabilities, while positive influences such as perceived usefulness, external influence, and cultural factors play a significant role in ensuring government agencies execute OGD policies in Taiwan (Yang & Wu, 2016). To make government data more accessible and reusable, the government has endeavored to establish dedicated open data coordinators within and between second-level agencies. The IDB also developed industrial policy plans for open data, such as the Open Data Application and Promotion Plan, and the Data Service Industry Application and Promotion Plan. The IDB organized competitions and hackathons to encourage startups and techies to utilize open datasets to generate new ideas and applications, and provided subsidies based on the proposals that businesses submitted. The ultimate objective was to establish an open data service industry that offered economic opportunities, such as data storage, processing, analysis, and application (Chen, 2022).

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In order to prepare datasets for open data purposes, agencies must acquire information-sharing capabilities from other agencies. To ensure the successful publication of these datasets to the public, agencies must also possess the necessary skills and familiarity with open data platforms and associated technical standards to manage interactive feedback loops within the open data ecosystem (Janssen et al., 2012). Institutions provide services and support for collective economic improvement. The capacity of institutions to promote learning, prevent uniformity of knowledge bases, and facilitate change in the ecosystem's competency structure is a key factor in resilience (Balland et al., 2015). The degree of resilience is influenced not only by the ability of institutions to drive change, but also by their own ability to change and evolve (Balland et al., 2015; Davis, 2010; Simmie & Martin, 2010). An evolutionary approach to resilience theory has been widely accepted in the academic community, highlighting the importance of institutions adapting over time. Institutions that resist change are inherently non-evolutionary and incapable of contributing to reconfiguration that could significantly enhance resilience or reflect economic realities following internal or external shocks.

4.3.2 The symbiotic dynamics of actor interactions in Taiwan's open government data ecosystem

In Taiwan's OGD ecosystem, the importance of interactions among diverse stakeholders—government agencies, private companies, and civil society—cannot be overstated. These interactions are vital for stability, innovation, and resilience. The ecosystem's health relies not just on the existence of these participants, but on the quality and depth of their collaborations. For instance, during the COVID-19 pandemic, the government faced challenges in disseminating real-time mask inventory data. Private-sector developers stepped in to create the "Mask Map," a real-time tracking system that helped the public locate available masks. This is a prime example of how multifaceted collaborations can solve immediate challenges effectively. Furthermore, Taiwan's Digital Minister, Audrey Tang, led the vTaiwan initiative, a civic technology platform that facilitates public discussions on policy issues. The government set up the stage, and citizens, experts, and activists contributed their perspectives, creating a truly democratic dialogue. Such initiatives not only increase citizen engagement, but also evolve policy in real time, boosting the ecosystem's adaptability and resilience.

Cross-agency collaborations add another dimension to this vibrant ecosystem. For example, the Ministry of Economic Affairs works in tandem with the Research, Development, and Evaluation Commission, showcasing that joint efforts can address complex governance challenges better than isolated actions. This also indicates strong political will, enhancing the ecosystem's stability. The private sector, notably tech companies, often plays the role of an innovation catalyst. Their collaborations with the government, particularly in developing data analytics tools, bring technological advancements that benefit the entire ecosystem. It's a win-win scenario where government gains technological prowess, and companies gain access to valuable data.

The ecosystem's sustainability goes beyond mere transactions; it's rooted in social cohesion

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and mutual trust. Taiwan's cultural emphasis on community well-being facilitates interactions among these diverse actors, reducing risks and speeding up decision-making. This synergy among stakeholders makes the Taiwanese OGD ecosystem robust, adaptable, and sustainable over the long term. All in all, the interactions within this ecosystem are not just additive but multiplicatively beneficial, contributing to its long-term viability. Once the general OGD policy guideline was established, the Office of Science and Technology (OST) delegated the task of developing and executing specific policies to the IDB under the Ministry of Economic Affairs (MOEA). The Open Data Alliance (ODA), an industrial organization that aimed to utilize open data and create market values, was created with the assistance of the IDB. This approach resembled the Taiwanese developmental state's practice of forming ad hoc bodies to connect the government with private capital.

4.3.3 Network integration and cohesion in Taiwan's open government data ecosystem

Networks are vulnerable to cognitive stagnation that can lower resilience (Malerba & Vonortas, 2009). When actors within a network are located in close proximity to one another and interactions are convenient, external influences may be reduced, ultimately weakening resilience. This suggests that there is a limit to how cohesive a network can be before its internal relationships hinder its ability to effectively integrate external influences. The function of networks in the context of resilience differs from the interaction among actors in other types of systems. While continuous, interconnected interactions among actors within an OGD ecosystem are encouraged for greater efficiency, resilience theory suggests that networks, which are a similar concept, can have negative consequences if they become restricted and isolated (Breschi & Malerba, 2005).

Network cohesion in Taiwan's OGD Ecosystem can be delineated as a triadic constellation where government, private sector, and civil society are tightly interlinked. Through centralized data repositories, symbiotic partnerships, and participatory governance mechanisms, Taiwan has masterfully crafted an ecosystem where each node adds value to the collective network, thus reaching a pinnacle of cohesion that serves as an exemplar for other nations. The NDC, for instance, has been diligent in aggregating datasets from various governmental departments, thereby acting as a nexus. This centralized approach yields not only efficient data dissemination but also establishes a foundational structure that begets inter-organizational coherence. Furthermore, the ecosystem displays an intricate web of collaborations characterized by bilateral and multilateral agreements among stakeholders. Private enterprises and startups are frequently seen leveraging publicly-available data to foster innovation, be it in the realm of healthcare, transportation, or environmental sustainability. In such instances, the seamless data interchange facilitates a mutual value creation mechanism that amplifies network cohesion. However, the crux of network cohesion lies in the participatory governance model that Taiwan espouses. Citizens are not mere passive recipients of open data but are proactively engaged in the data governance process through mechanisms such as the vTaiwan platform. Through platforms like these, policy issues are deliberated in a manner

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that fosters collective intelligence, thereby knitting a social fabric that is both inclusive and cohesive.

4.3.4 Cultivating resilience via adaptive mechanisms in the OGD ecosystem

An ecosystem that is well-connected to external influences and has a culture of learning that embraces external knowledge is observed to achieve greater overall resilience (Balland et al., 2015). Innovations occur in response to changes in the external environment (e.g., user demand) and are based on internal organizational choices (Walker, 2014). Some scholars have used innovation theories in order to understand OGD adoption (Harrison et al., 2012; Kaasenbrood et al., 2015). While internal adaptation within an ecosystem is inevitable, external factors have the greatest influence on the ecosystem's future. Ecosystems that are more internally focused tend to be more rigid and less flexible to external influences (Christopherson et al., 2010). Changes in consumer demand or external innovations have the potential to significantly alter the competitiveness of an ecosystem. Sensitivity and adaptation to external factors are central to resilience theory. Ecosystems that can assess the external landscape and adapt to take advantage of new opportunities logically achieve higher resilience to potential shocks (Dabson et al., 2012). External adaptation is necessary to enable the ecosystem to monitor potential threats from the external environment and prevent destabilization.

Taiwan's OGD system serves as a model for adaptive governance in our digital age. The system's agility and responsiveness are central to its effectiveness in public administration, attributes derived from key design features. It adopts a multi-stakeholder model, incorporating input from government, businesses, and civil society to be attuned to diverse needs. Technologically, the system is built for scalability and rapid modification, facilitated by its modular structure. This enables immediate adjustments for evolving security requirements or new data categories. The OGD policies are continually updated, with audit feedback integrated to foster a culture of continuous improvement. Beyond mere adaptability, the system also places emphasis on knowledge creation and learning cultures, key ingredients for a resilient ecosystem. Such an environment not only drives internal adaptation but also fuels innovation. Actors within this ecosystem are empowered to acquire new capabilities through collaboration and interaction. This symbiotic learning landscape has proven to be crucial for stimulating innovation. Resilient ecosystems are characterized by their ability to encourage local learning while remaining open to global influences. However, a word of caution is warranted. An ecosystem can become too insular if its internal adaptive tendencies overwhelm it, causing innovation to stagnate. Such ecosystems may become increasingly susceptible to collapse under external shocks. Therefore, while adaptability and a strong learning culture are essential, they must be balanced with openness to external inputs to ensure enduring resilience and relevance.

4.3.5 Sectoral diversification as a resilience mechanism

Technological shocks by definition are destructive forces that are capable of disrupting competitive advantages and thus livelihood. A serious recession, natural disaster, or shift in consumer demand may spawn a set of circumstances that necessitates a reallocation of

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resources away from previously held competitive advantages. An ecosystem's singular focus on a sector or industry limits its ability to recover from a negative event (Balland et al., 2015). Avoiding this dependence on a single sector is correlated with greater resilience. More dynamic systems, especially those that are diversified (Rose & Krausmann, 2013; Simmie & Martin, 2010) and able to rely more heavily on outside influences (Dabson et al., 2012) are structured in a more resilient manner. Systems that choose instead to specialize in any particular sector in the name of reaping greater rewards therein, unwittingly place themselves at a disadvantage in the face of extraneous shock. Dependence on connections established and sustained within networks can lead to uniformity, decreased innovation, and ultimately reduced resilience.

Data marketplaces in Taiwan have emerged as a way to bridge the gap between data providers and data consumers. These marketplaces enable businesses, researchers, and other organizations to buy and sell data in a secure and transparent manner. The development of data marketplaces in Taiwan began around 2014 when the government recognized the potential of data-driven innovation and started to promote the concept of open data. In 2015, the government launched the "Digital Nation and Innovative Economic Development Program" (DIGI+), which included the establishment of a national data exchange platform. One of the first data marketplaces to emerge in Taiwan was the "Open Data Marketplace," which was created by the Institute for Information Industry (III) in collaboration with the government's DIGI+ program. The Open Data Marketplace allows data providers to upload their data and set prices for different types of data sets. Data consumers can then search for and purchase the data they need through the marketplace. The Open Data Marketplace also provides a secure environment for data exchange, with built-in data privacy and security measures. Another notable data marketplace in Taiwan is the "Data Store" platform, which was launched in 2017 by the government's National Development Council. The Data Store platform offers a range of data sets from various government agencies and private companies, including geospatial data, transportation data, and weather data. The platform allows data consumers to search for and purchase data sets, and provides data providers with a secure and transparent way to monetize their data. In recent years, several other data marketplaces have emerged in Taiwan, including the "T-Brain AI Data Marketplace" and the "Taiwan AI Labs Data Marketplace." These marketplaces specialize in providing access to data sets for artificial intelligence and machine learning applications. The development of data marketplaces in Taiwan has been driven by the government's efforts to promote open data and digital innovation. These marketplaces provide a platform for data providers and consumers to exchange data in a secure and transparent ecosystem.

4.4 Value creation through open government data: An ecosystemic approach integrating platform models and user engagement

The goal of unlocking new value from OGD goes beyond just having a strong platform; it requires an ecosystem approach that involves a wide range of users from different fields. Achieving this depends on both a solid data

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infrastructure and ongoing user engagement. Even with ample data, its true value can only be unlocked through coordinated efforts to engage the community and provide the right tools and support. Research increasingly shows that a diverse mix of expertise is more effective for creative problem-solving. While OGD can boost citizen involvement and collaboration, the success of these efforts relies on political support, inter-agency cooperation, and aligned goals among participants. In the practical application of OGD, having easily accessible datasets benefits a broad range of stakeholders. However, it's the ability to recombine and reuse this data that truly adds new value and drives innovation (Kucera & Chlapek, 2014). Taiwan's OGD system exemplifies best practices in blending technological robustness, governance structures, and user engagement. It isn't mere conjecture; it's substantiated by several compelling facts. Firstly, consider the platform's technological architecture. Unlike static databases, Taiwan's OGD platform features an API-based architecture that facilitates data interoperability. This enables third-party developers to create over 200 apps and services that leverage this data, ranging from real-time traffic monitoring to air quality indices, thereby converting inert data into actionable insights. Secondly, user engagement isn't an afterthought; it's an integral part of the design process. The system includes features like interactive dashboards and customizable data visualizations, a testament to its investment in user experience (UX) design. Furthermore, the platform has mechanisms for users to provide feedback directly, and this feedback has led to tangible improvements in the system. For instance, after users highlighted accessibility issues, the OGD team responded by enhancing the platform's mobile responsiveness. Thirdly, the multi-stakeholder governance model brings diverse perspectives into the decision-making process. Notable collaborations between government agencies, private enterprises, and civil societies have led to successful initiatives like the Taiwan GeoSpatial One-Stop Portal. This initiative amalgamates data from multiple government departments, creating a comprehensive geographical information system for public use.

Moreover, the adaptive nature of Taiwan's OGD policies fosters a culture of ongoing improvement. The government regularly releases whitepapers detailing updates and future plans, openly integrating both internal and external audits into policy adjustments. For instance, a recent policy update expanded the categories of data released, based on continual assessments and public input. Each of these facts underscores the holistic strategy Taiwan's OGD employs to create value—its technologically adaptive platform, its emphasis on user-centric design, its inclusive governance model, and its commitment to ongoing policy refinement—ensure not only the system's current efficacy but its sustained impact and relevance.

Taiwan's OGD system is a paradigm of how to effectively blend technological infrastructure, governance models, and user engagement for optimized value creation. Central to this is a platform model that serves more than as a data repository; it is an adaptive, scalable foundation that invites third-party enhancements, converting data into actionable insights. Equally crucial is the system's focus on user engagement, facilitated through feedback loops and UX designs, making the data not just accessible but also actionable

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for the public. These two pillars, technological scalability and user-centricity, are harmonized through a multi-stakeholder governance approach involving government, the private sector, and civil society. This collaborative ecosystem is further enhanced by its capacity for continual learning and policy adaptation. Consequently, Taiwan's OGD isn't just a data-sharing mechanism, but a dynamic tool for innovation, societal advancement, and policy refinement. It exemplifies an ecosystem where adaptability and user involvement are built into its very fabric, guaranteeing its long-term relevance and impact.

5. Conclusion and Discussion: Navigating the Future of Open Government Data Ecosystems

The argument presented in this paper is that adopting an ecosystem perspective can help governments develop a more robust and sustainable OGD infrastructure, which is specifically designed to promote growth and sustainability. Therefore, an ecosystem should be driven by the core interaction between producers and users and allow them to exchange information, knowledge, goods or services (Amit & Zott, 2012). It can also leverage the power of data-based tools to create community feedback loops which allow easier scalability than traditional approaches to regulating content (Ceccagnoli et al., 2012). In the face of larger-scale of open data waves, an OGD ecosystem requires effort from people in a variety of roles and disciplines. The success of an ecosystem greatly requires open innovation strategy, which refers to the targeted opening of the innovation process to the outside. Open innovation strategy is focusing on orchestrating external resources, as well as building actively engaged communities for ecosystem governance, rather than managing internal resources and eliminating barriers to entry (Chiaroni et al., 2011). The attention of governments to open data is not only stimulated by the strategies of the front runners, but also by the development of technologies that enable the creation of new services based on OGD. Even though technological innovation doesn't necessarily translate into users' value (Magalhaes & Roseira, 2017). Due to its unmatched capacity to generate innovation, the private sector plays an essential role as a stakeholder in the OGD ecosystem (Harrison et al., 2012).

Taiwan's OGD ecosystem serves as a compelling case study for the application of resilience theory, characterized by five key pillars: networks, institutions, interactions, adaptation, and diversity. First, Taiwan's OGD benefits from a robust network architecture, fostering trust-based interactions across governmental entities, private sectors, and citizens. This network-centric approach promotes cooperative problem-solving and adaptive learning, as demonstrated by initiatives like the "Open Data Application and Promotion Plan" and hackathon events. These network activities serve to amplify the resilience and societal impact of Taiwan's OGD system. Second, institutional strength in Taiwan is evident in policies and strategic plans dating back to the early e-Government guidelines of 1999, focusing on transparency and civil liberties. This institutional foundation creates a conducive environment for sustained productivity, strengthening the nation's OGD resilience. Third,

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Taiwan's OGD ecosystem thrives on multi-stakeholder interactions involving government, industry, and public participation. The density and quality of these interactions lead to a responsive and adaptive system capable of navigating external challenges and opportunities effectively. Fourth, adaptation is a defining trait of Taiwan's OGD system. The appointment of dedicated open data coordinators to manage inter-agency collaborations exemplifies the system's agility in policy implementation and data sharing, allowing it to adapt to both local and global changes without compromising its core functionalities. Taiwan's OGD ecosystem stands as a model of resilience, rooted in a nuanced application of the resilience framework's five pillars. This case study illustrates how resilience theory can guide the development and refinement of OGD initiatives, both in Taiwan and globally.

Since the COVID-19 pandemic has served as a critical inflection point for OGD elevating its relevance while simultaneously exposing its limitations. This juncture has accentuated the imperatives of data availability, transparency, and accuracy, foundational principles that OGD aspires to uphold. The ramifications are multifaceted, shaping both the challenges and the potentialities inherent in OGD's societal and instrumental value. The pandemic has elevated OGD platforms to indispensable resources, serving an eclectic cohort that spans researchers, policymakers, and the citizenry at large. These platforms have proven invaluable in predictive analytics, contact tracing, and the strategic allocation of essential resources, affirming their societal utility in crisis management and public governance. Moreover, the exigencies of the pandemic have accelerated the digital transformation of governmental structures. This swift metamorphosis, although beset by initial challenges, harbors long-term benefits for the advancement and accessibility of OGD platforms, and consequently, for data-driven decision-making processes. The pandemic has unmasked vulnerabilities in the OGD ecosystem, especially in terms of infrastructural robustness and data governance. Issues such as inconsistent data standards and the risk of misinformation have surfaced, prompting an imperative for reevaluation and fortification of OGD frameworks. This scrutiny necessitates targeted investments in data infrastructure and stringent governance protocols to enhance reliability and resilience. Lastly, the global scope of the pandemic has spotlighted the need for international cooperation, thereby elevating OGD to the status of an international public good. Cross-border data sharing has been instrumental in facilitating collaborative research endeavors and transnational policy initiatives.

In advancing the discourse, this paper introduces a quintet of resilience capabilities, aiming to foster a nuanced discussion on the confluence of platform and ecosystem models to augment the sustainability and resilience of OGD initiatives. Leveraging these resilience dimensions enables the identification of potential vulnerabilities or avenues for capability enhancement within the OGD ecosystem, thereby facilitating its evolution via platform models. Furthermore, the study endeavors to articulate a higher stratum of thematic interpretation, premised on the synthesis of extant literature, to buttress future framework development. Significantly, the article underscores the imperatives of user-interface design and diversified OGD application

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strategies, both indispensable for optimizing the ecosystem's value proposition.

In light of the foregoing analysis, several avenues for future research present themselves. The current work provides a taxonomy of five resilience capabilities; however, in-depth case studies focusing on these dimensions within different OGD ecosystems could offer nuanced insights into their applicability and effectiveness. Furthermore, given the importance attributed to user-interface design in this paper, future research should aim to empirically evaluate the impact of design elements on user engagement, data utilization, and ultimately, on ecosystem resilience. Further research should also delve into diversified strategies for OGD application in various sectors like healthcare, transportation, and education. How do these sector-specific strategies contribute to ecosystem resilience? Each of these research directions not only carries the potential to augment our empirical understanding of OGD ecosystems, but also to influence practical applications and policy-making, thereby ensuring the ecosystem's sustained resilience and societal impact.

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以韌性的生態系統觀點探討臺灣開放政府資料平台

Towards a More Resilient Ecosystem: Case Study of Open Government Data in Taiwan

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摘　要

有鑒於開放資料領域中缺乏對韌性（resilience）的探討，然而韌性對一個生態系統的發展卻是不可或缺。本研究旨在探討建立開放政府資料（Open Government Data, OGD）生態系統過程中，將韌性因素納入考量的重要性。透過在臺灣進行的個案分析，本研究呈現生態系統與平台模式的整合架構，從而建構出具韌性且永續發展的開放政府資料平台，以期在面對系統性衝擊與危機時，能夠展現出高度適應性及彈性。本研究以具備韌性的生態系統觀點，強調平台模式、線上及線下使用者介面的互補性在開放政府資料生態系統中所扮演的關鍵角色。本研究透過(1)提出臺灣的個案研究，以呈現OGD生態系統與平台模式的整合效益，以及(2)從韌性理論的角度提供對OGD生態系統設計的洞見。

關鍵字：韌性、生態系統、平台、開放政府資料

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