Digital Ecosystems and Business Innovation as Sustainable Transition Accelerators of Island Smart Cities

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Abstract

This study examines how digital ecosystems and business innovation interact as co-evolving mechanisms to accelerate the sustainable transition of island smart cities. It presents island cities as socially and technically limited yet living systems, that with the aid of smart technologies immensely figure resources, energy, climate change challenges, tourism seasonality, and also have great potential for accelerated learning. It is argued that digital ecosystems provide infrastructures of interoperability, data and collaboration, which make it possible to connect people, exploit data in real-time and have contributing governance. Moreover, entrepreneurial innovation is the transformation of technological capabilities into new business models, organizational practices and ways of creating value, particularly in four major areas: energy, mobility, tourism and the circular economy. The article gives particular attention to open innovation, living labs and ecosystem governance being collective learning and co-creation mechanisms. It illustrates that a combination of digital ecosystems and entrepreneurial innovation management is essentially a synergy that leads to organizationally "smart" and resilient island cities. *The findings suggest that the interaction between digital ecosystems and business innovation enhances organizational intelligence, resilience, and adaptive capacity in island cities.*

Keywords: smart cities on islands, digital ecosystems, ecosystem governance, business innovation, islands.

Introduction

Smart cities are currently one of the most powerful ideas for developing cities around the world. They embody the increasing tendency of the cities to utilize innovative governance models, data-driven infrastructures, and digital technologies to address issues that are complex. Initially, the smart city concept was largely associated with the deployment of information and communication technologies (ICTs) aimed at optimizing urban services and enhancing operational efficiency. However, with the passage of time, more people have resisted the technocentric understanding of smartness and have instead put more emphasis on the institutional, social, and organizational aspects of urban transformation (Hollands, 2008; Mora et al., 2019).

This change is crucial for island cities because they are limited and highly interdependent socio-technical systems. Island urban environments have a unique set of characteristics that include geographic isolation, limited access to resources, fewer economies of scale, and greater vulnerability to environmental hazards. These features of the environment cause a few challenges that have to be dealt with on an ongoing basis, such as dependency on external energy sources, the seasonality of tourism, the fluctuation of the economy, and the impact of climate change (Pelling & Uitto, 2001). However, the fact that island systems are closed means that they have the ability to experiment, coordinate, and learn at an accelerated rate, which is why island cities are now considered to be strategic laboratories for sustainable urban innovation (Grydehøj & Kelman, 2017).

Both digital ecosystems and the process of business innovation are becoming more and more recognized as the main driving forces behind the island smart cities transition to sustainability. While digital ecosystems serve as the connective, cognitive layer where platforms, data, and stakeholders interact, business innovation takes the technological potential to a new level of socio-economic value generation. *However, existing research on smart cities has largely examined digital ecosystems and business innovation as separate domains, without sufficiently addressing their integrated and co-evolutionary relationship. There is a lack of studies that explain how these two dimensions jointly contribute to organizational transformation in island smart cities.*

To address this gap, this article adopts an integrated perspective, arguing that island smart cities undergoing sustainable transition should not rely solely on the deployment of technologies, but require a combined understanding of digital ecosystems and business innovation as interdependent drivers of organizational transformation.
In fact, it involves a major rethinking of urban governance and management that must be inspired by business innovation management as a way of thinking. An urban innovation management mindset sees a city as an organizational system capable of adaptive learning that can not only identify and attract necessary people and resources but also create, orchestrate, and coordinate digital ecosystems, entrepreneurial dynamics, and continuous change.

This study addresses the following research question: *How do digital ecosystems and business innovation interact as co-evolving mechanisms that facilitate the sustainable transition of island smart cities?* Taking the perspective of an ecosystem and

organization, first, the paper promotes a shift in theory from technology-driven smartness to organizational intelligence. Secondly, it stands at the intersection of digital ecosystem theory and business innovation management in an urban setting. Thirdly, it points out the uniqueness of islands as catalysts of systemic innovation rather than being only inhibitors.

2. Smart Cities as Organizational Systems

2.1 Smart cities

The sustainable transition of island smart cities is accelerated when digital ecosystems and business innovation are two sides of the same coin in a single, integrated framework. Thus, this relationship is not linear, but characterized by dynamic feedback and co-evolutionary mechanisms, where technological capabilities, organizational practices and business models mutually evolve over time (Jacobides et al., 2018; Adner, 2017).

Open data and interoperable digital platforms allow for continuous experimentation and testing of ideas for innovative solutions. On the one hand, businesses and research institutions use data to create locally oriented services, and, on the other hand, public authorities can rely on the information to design and execute better policies. According to the literature, data-driven ecosystems promote innovation from an experimental and learning perspective, especially in complex, spatially constrained environments such as islands (Mora et al., 2019; Meijer & Bolívar, 2023).

Digital tools improve participatory governance by facilitating consultation, collective decision-making and priority setting. These dimensions of participation contribute to social acceptance of innovation, reduce information asymmetries and, therefore, reduce the risk of intervention failure. Recent research reveals that the integration of digital participatory mechanisms is a vital element for the maturity of smart cities, especially for small urban communities (Cardullo & Kitchin, 2019; Tomor et al., 2019).

The interaction of digital ecosystems with business innovation results in, among other things, increasing the climate resilience of organizations. Using a combination of sensors, monitoring systems, digital data analytics and flexible business solutions, island cities will be able to better cope with extreme weather conditions, natural disasters and complex crises. Currently, resilience is considered as the result of the mutual influence of digital infrastructure, institutional capacity and innovative organizational practices, and not as a purely technological property (Sharifi, 2019).

In general, the positive interaction between digital ecosystems and entrepreneurial innovation plays the role of a springboard for the evolution of smart island cities from fragmented action to an integrated, flexible and environmentally friendly urban governance strategy.

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Open data and interoperable digital platforms, first, allow for continuous experimentation and testing of ideas for innovative solutions. On the one hand, businesses and research institutions use data to create locally oriented services, and, on the other hand, public authorities can rely on the information to design and execute better policies. According to the literature, data-driven ecosystems promote innovation from an experimental and learning perspective, especially in complex, spatially constrained environments such as islands (Mora et al., 2019; Meijer & Bolívar, 2023).

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2.2 The Evolution of the Smart City Concept

Early smart city initiatives primarily emanated from major technology vendors and political agendas that were focused on infrastructure. Thus, smartness equated to the deployment of sensors, real-time monitoring and communication systems, and centralized data platforms with the objective of achieving cost reductions and operational efficiencies in the provision of urban services such as traffic management, energy distribution, and public safety. In fact, the extent to which these measures have resulted in increased efficiency and better operational control can be quantified, and thus, the perception that technological innovation is the main agent responsible for the modernization of cities is reinforced.

Nonetheless, technocentric approach proved to have numerous drawbacks as its dominance was gradually being eroded. The one-sided concentration on technology as a way of fixing everything largely ignored the fact that cities determine their routines not only through practices and organizational structures but also through social situations and institutional arrangements. The criticism arose out of the realization that there were risks of such phenomena as the concentration of power in central government, lack of transparency and non-involvement of citizens in decision-making; in addition, technology is not neutral since it embodies the values, priorities and power relations of its designers (Hollands, 2008; Kitchin, 2015).

If one takes a look at the modern smart city research, it is apparent that, in response to the issues raised above, there has been a gravitation towards integrated conceptual frameworks that give prominence to human capital, social innovation and institutional capacity. Presently, the city is perceived as a multidimensional socio-technical and organizational entity which, from a technological point of view, is merely a support mechanism as opposed to being the driving force at the centre of everything. It is generally acknowledged that the real smart city lies less in technological innovation and

more in the ability of cities to organize ecosystems of collaboration and learning (Mora et al., 2019; Meijer & Bolívar, 2016).

2.3. Cities as Complex Adaptive Organizations

The concept of a city as an organization that is embedded within a system implies that the city is a dynamic and adaptive entity consisting of various structures, processes, and relationships which change over time. The forefront of urban complexity literature describes a city as a socio-technical system of immense intricacy and interdependence of constituent parts. Nevertheless, such a system is not only capable of being "environmentally intelligent" in the sense of having technological infrastructures but it is also so in the sense of being able to adapt constantly through coordination and systemic adaptation of actors (Batty, 2022).

Accordingly, it is the adaptation capability and the learning of institutions that constitute the main features of urban resilience. Studies on transformative and adaptive governance thus underline that cities improve their long-term functionality once they provide the opportunities and put into effect the mechanisms for experimentation, cooperation, and policy and resource adjustment in a continuous manner (Frantzeskaki et al., 2021).

Characteristics of governance in an organizational sense become more pronounced in islands and other small-scale urban settings where the tightly knit nature of subsystems increases not only the delimitation and spreading of dangers but also the quick dissemination of innovations. The island-focused literature is raising the point that there is a requirement for governance that is flexible and adaptive and that takes advantage of institutional learning and collaboration across sectors (Grydehøj, 2020).

2.4 The Role of Business Innovation Management in Urban Transformation

Taking on an innovation-management-in-business-perspective mindset at the city level means substantially departing from traditional technocratic planning paradigms to urban transformation strategies which are organizationally oriented. Instead of an exclusive emphasis on regulatory compliance and service delivery, urban authorities are called upon to assume the role of innovation orchestrator, shaping the conditions under which new ideas emerge, are tested and scaled up (Torfing, Sørensen and Røiseland, 2019).

This way of thinking includes an interdependent set of skills that consist of visionary strategic planning, handling and prioritization an organisation's portfolio of innovative ventures, creation of public-private partnerships and setting up a feedback loop mechanism for learning from an on-going experimentation scenario. Besides, nowadays public innovation and co-creation of policy literature present us with the fact that when the structures for collaboration, experimentation and reflection exist, innovation gets embedded institutionally (Ansell and Torfing, 2021; Desouza and Jacob, 2017).

The focus of innovation in a technologically advanced and digitally savvy urban environment, is not rooted in just the technological solutions but rather how the organizational capabilities such as governance, portfolio management and building innovation ecosystems help to implement these technological solutions. Documentation shows that it is when cities act as innovation platforms that there is urban transformation and not simply when they act as service providers (Meijer and Bolívar, 2016).

Being located on an island or surrounded by other natural and socio-economic factors that limit production and consumption patterns, the reorientation towards innovation management becomes a matter of resilience of the urban system through closely linked investment prioritization, risk management and institutional learning (Ansell and Torfing, 2021).

3. Digital Ecosystems as Supporting Infrastructures for Island Smart Cities

3.1 Definition of Digital Ecosystems in the Urban Context

Digital ecosystems are configurations of different digital platforms, application and data, architectures, and governance mechanisms, which facilitate interaction, value co-creation, and exchange among heterogeneous actors in the context of a network (Jacobides et al., 2018). In comparison to information and communication technologies, digital ecosystems possess the qualities of openness, modularity, and they operate under evolutionary principles. Besides, they also stimulate organizational learning, and innovation, allowing groups from various sectors and disciplines to collaborate and break down their institutional boundaries whilst collectively solving problems.

As for digital ecosystems and cities, they scale up to becoming a very significant infrastructural layer in coordinating and integrating all those urban functions that are really complex and diverse. Moreover, the case for these ecosystems features the shared attributes, such as “data places” and “spaces for collaboration”, which are public, protected, and empresarial at the same time and without excluding the research, education and the citizen sector community thus connecting these stakeholders in different ways one can name. This concept of organizational intelligence sees the city as a rich and varied system capable of gathering, understanding, and using its knowledge instantaneously.

In particular, for island smart cities, digital ecosystems constitute an indispensable technological infrastructure. Certain necessities such as interoperability and replacing of functional barriers, which were brought about by the geographical location, scarcity of resources, and heavy dependence on other networks outside the island’ neighborhoods, had made these requirements almost unavoidable. They are the “backbone” or core support of an urban organization that allows island cities to operate as a single and integrated system sectors such as energy, mobility, water management, tourism, and civil protection (Kitchin, 2014; Mora et al., 2019).

Besides, researchers argue that digital ecosystems are not merely technologically neutral constructions but, in fact, they reflect the institutional decisions, rule systems, and contestations for power. To this extent, their performance is dependent on how well they are integrated with the wider regime of governance and patterns of organizational learning (Meijer & Bolívar, 2016).

3.2 Main Functions of Digital Ecosystems in Island Environments

One of the main objectives of the digital ecosystem operating in an island setting is to foster interoperability among its members. The breakdown of digital infrastructures and the use of incompatible data formats and standards have, over the years, been major stumbling blocks to the achievement of a well-coordinated urban design and planning. Interoperability of digital platforms has been praised as the feature that comes closest to facilitating the breaking down of administrative and sectoral" silos" thus enabling the adoption of strategies which are geared towards systemic optimizations. Islands, on the other hand, where infrastructure amounts are minimal and hence going in to pertain a small margin of idle capacity, are very dependent for their sustainability on the capability of the whole to be managed if one factor is to be critical (Kitchin, 2014).

A second core function of the system is to provide instant data at any time of the day or week. Through the help of a wide array of sensors installed in the everyday environment, if not audio-visual and via internet, a large volume of data pertaining to the energy consumption, the flow of people and their travel pattern, the state of the environment, and the utilization of natural resources is always available for the knowledgeable observer. Further, what makes the later so unique and efficient is that this is the part which cleverly finds and puts together the missing links between data and evaluation thus provisioning the policymakers with most probable courses of actions. This type of scenario has immediate implications for and is just indispensable for the island context, in particular, because the wave-like character of the tourist ostentation, which is the main source and cause of both consumption and production of wastes, can, if it prolongs itself, very quickly break the entire system of urban such as to cause the undermine the whole endeavor of sustainability and therefore eventually it is the Suratmorning escape.

Besides, digital ecosystems can allow for a much broader participation in the decision-making process by giving access to more citizens, businesses and entities of the city. Digital participation platforms not only allow different stakeholders to share their problems and concerns but also help the urban system by generating ideas and providing citizens with channels of communication and collaboration (Nam & Pardo, 2011; Cardullo & Kitchin, 2019).

Last but not least, through providing shared resources and infrastructure, digital ecosystems also enable partners from different sectors to collaborate. This partnership is birthed when each party, be it a research institution, a public body or a startup, combines their resources with other parties to collectively develop, test and then scale up each innovative solution. Such a capacity, overall, nurtures an ecosystem approach

to urban development on which collaborative innovation depends rather than on individual actors (Adner, 2017; Leminen et al., 2021).

Digital ecosystems, therefore, provide island smart cities with infrastructures that make possible organizational innovation. They represent the elements of an urban technology/operation system but first and foremost the urban technology/operation systems.

4. Business Innovation as a Mechanism for Organizational Transformation in Island Cities

Business innovation serves as the perfect assistant to digital ecosystems by providing a channel through which the potential that comes with the latest technologies and infrastructures can be harnessed and turned into business-oriented, organizational and social results that are sustainable. In the case of island smart cities, the business innovation component, which depends on digital technology, extends, along with the foregoing, to the public-private cooperation which is partly altered through business model innovation, changes in value premises, and organizational capacity development (Foss & Saebi, 2018; Jacobides et al., 2018).

Moreover, the increasing interest in value creation, as highlighted in recent literature, has shown that value cannot come from technology alone but is the outcome of an inter-organizational alignment of technology, capabilities and processes. Harmonizing the different actors and their resources, knowledge, and capabilities is the fundamental process of ecosystem innovation (Autio et al., 2018). In fact, the marketplace is relatively smaller and external dependency stronger in the case of island, hence innovation serves as a strategic tool for resilience and economic diversification.

Business models that promote digital technology and sustainability have become increasingly important in critical sectors such as energy, mobility, the tourism sector, and the circular economy. Cohen and Kietzmann (2014) observe that recent innovations in shared and electric transportation, supported by digital technology, can bring environmental benefits and offer better functionality especially in small-scale island urban systems. Similarly, the deployment of smart microgrids and the formation of energy communities can lead to greater energy independence and lower the need for energy import (Lowitzsch et al., 2020).

Business innovation in tourism revolves around smart destinations, visitor management through digital platforms, which help in turning the pressures on the islands' socio-natural resources into less and enhancing residents' life quality (Gretzel et al., 2015; Myrovali et al., 2025). Exactly at this moment, these circular business models, which utilize digital means for traceability and smart resource management, are acknowledged as the most crucial element of organizational transformation toward sustainability in island cities (Geissdoerfer et al., 2018; Bocken et al., 2016).

5. Synergies between Digital Ecosystems and Business Innovation

The sustainable transition of island smart cities is faster when digital ecosystems and business innovation are mutually supportive in one integrated framework. The relationship between the two is non-linear. Instead, it is marked by dynamic feedback and co-evolutionary processes, where technological capabilities, organizational practices, and business models gradually change together (Jacobides and al., 2018; Adner, 2017).

Firstly, open data and interoperable digital platforms facilitate the ongoing experimentation and adjustment of innovative solutions. Firms and research labs use data to create products that fit the needs of the locals, whereas public officials use the data for better policymaking. Some studies point out that data-driven ecosystems increase the experimental and educational side of innovation, especially in difficult and geographically limited areas such as islands (Mora and al., 2019; Meijer & Bolívar, 2023).

Secondly, digital tools make participatory governance more accessible by easily facilitating consultation, collective decision-making, and prioritization processes. This participatory aspect helps with the social acceptance of innovation, thus reducing information asymmetries and the intervention risk. The integration of digital participatory instruments is shown to be a key factor in the success of smart cities, particularly in small-scale urban communities (Cardullo & Kitchin, 2019; Tomor and al., 2019).

Thirdly, the integration of digital ecosystems and business innovation contributes significantly to both climate and organizational resilience. The smart combination of sensors, monitoring devices, digital data analytics, and adaptable business solutions can help cities on islands prepare better for extreme weather, natural disasters, or complex crises. Resilience is nowadays viewed as a side effect of digital infrastructure interaction, institutional capacity, and innovative organizational practices rather than just a technology feature (Sharifi, 2019).

The interaction between digital ecosystems and business innovation can be understood through three key mechanisms: data-driven experimentation, participatory governance, and the co-production of resilience. These mechanisms collectively enable continuous learning, adaptive decision-making, and systemic urban transformation.

6. Open innovation and ecosystem governance in island cities

An innovative governance approach that facilitates collaboration between government, citizens, and other stakeholders is fundamental to the success of smart cities. Participatory and collaborative aspects are emphasized in many smart city governance processes (Giffinger and al. 2007, Sharifi 2019).

Communication channels between stakeholders (e-government, e-participation, social media, etc.) by providing access to documents, transactions, feedback, voting on

initiatives and other bureaucratic tasks, improve participation and engagement, thus increasing transparency, accountability and responsiveness of the administration in decision-making/implementation processes.

This governance model improves the quality of the government-citizen relationship by facilitating good faith and commitment to democratic institutions.

Smart governance calls for a coordinated, cross-sectoral, and multidisciplinary effort that not only lays out a clear strategy but also provides urban transformation with the necessary resources (money, subsidies, etc.). It guarantees interoperability of systems and integration of solutions at a level that they can most effectively collectively achieve strategic goals designed to reduce complexity and uncertainty in urban management. On the legal side, it needs regulatory frameworks in terms of design, implementation, user privacy, and ownership of data to foster sustainable digital urban development (Sharifi 2019).

Open innovation is a main requirement for digital ecosystems to work and for business innovation to be improved in today's smart cities. Unlike closed and hierarchical knowledge production models, open innovation revolves around the connectivity of diverse actors, the flow of knowledge beyond organizational boundaries, and the joint creation of solutions at the ecosystem level (Chesbrough, 2020; Jacobides and al., 2018). In the case of islands where resources, skills, and institutional capacities are all scarce, open innovation is not simply a strategic choice but rather a prerequisite for sustainable urban development.

Here, the idea of ecosystem governance provides a suitable basis for embedding open innovation in island cities. Moreover, governance is not only concerned with regulating, but it is also seen as a process of coordinating relationships, resources, and knowledge exchanges between public authorities, business, academia, and civil society. Research indicates that such governance styles work well in complex and uncertain situations wherein no single actor is knowledgeable enough or has enough capacity to overcome the situation (Ansell and Torfing, 2021; Meijer and Bolívar, 2023).

Living labs, innovation hubs, and pilot facilities, in this case, serve as critical organizational learning infrastructures. These facilities make it possible to test, gather real data, and tailor solutions to actual use conditions, thus lowering failure risk and capacity to extend is raised by successful interventions. Especially in island cities where one can take very few mistakes, living labs serve as intermediary mechanisms that close the gap between planning at the strategic level and implementation (Leminen, 2020; Greve and al., 2021).

Moreover, such mechanisms enable institutional and organizational learning as they provide continuous feedback from users, businesses, and local actors. Therefore, island cities become capable of policy revision, regulatory framework adaptation, and governance development that is more flexible and participatory through such a process. The shift turns cities from being passive consumers of technological solutions to

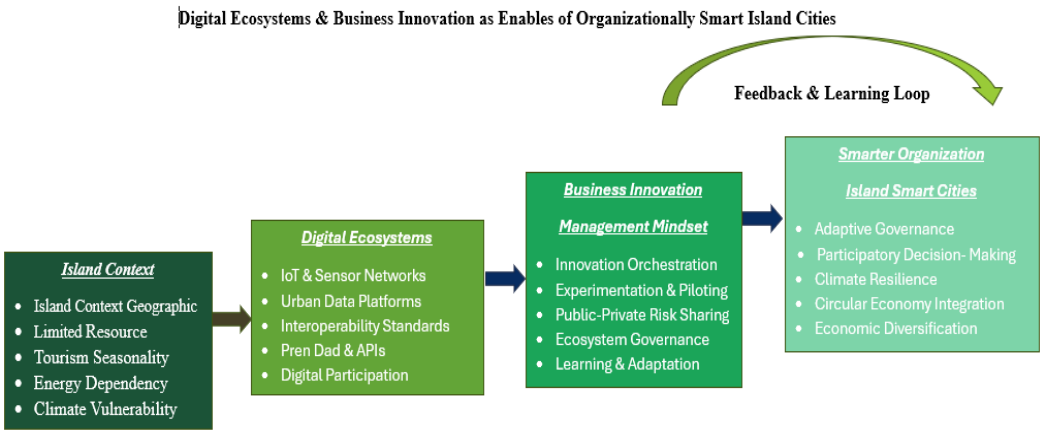
becoming active co-producers of innovation, hence increasing the sustainability of the solution in the long run (Tomor and al., 2019).

Thus, on their way to the pursuit of sustainability, island cities may be considered as "sustainable development laboratories" in that they produce, test, and disseminate innovative models of policy and governance beyond their local confines. Through the knowledge and practices transfer facilitated by the ecosystem approach, the role of islands as experimentation fields and pioneers of the urban sustainable transition is strengthened (Mora and al., 2019).

Open innovation and ecosystem governance, hence, serve as two foundational pillars for the organizational change in island smart cities. Utilizing digital ecosystems, entrepreneurial innovation, and participatory mechanisms jointly, island cities are able to evolve in ways that support a sustainable transition that is adaptive, resilient, and socially legitimate.

7. Conceptual Context: Digital ecosystems and business innovation as enablers of organizationally smart island cities

Figure 1 shows the conceptual framework of the study, which consists of three core components: (a) island-specific conditions, (b) digital ecosystems as enabling infrastructures, and (c) business innovation as a transformation mechanism. These components interact dynamically, leading to sustainable urban transition outcomes. The framework employs a multi-level, ecosystem approach where sustainable transition is considered the outcome of the continuous interaction of technological, organizational, and institutional factors.



The framework draws on the specific attributes of island cities such as geographic isolation, resource scarcity, tourism seasonality, and heightened climate vulnerability. These residential attributes act as both limitations and drivers for innovation. Digital

ecosystems are the technological heart of the framework, supplying connectivity, data gathering and processing, and the capability to link up different city systems.

With a business innovation management approach, urban areas are considered as adaptive, learning systems that can cope with complexity and uncertainty. This approach, for island cities, isn't just about making a strategic decision but rather it is about structurally ensuring policy sustainability and resilience.

8. Conclusions

This article points out that the sustainable transition of island smart cities cannot be the result of scattered technological interventions but a deep organizational transformation in which digital ecosystems and entrepreneurial innovation coexist in a single ecosystem framework.

To address sustainability and resiliency issues, island cities need to go beyond a strategic choice and treat business innovation management as a structural necessity. In this way, the adoption of a business innovation management mindset enables cities to operate adaptive and learning systems that can handle complexity and uncertainty.

The article demonstrates that the sustainable transition of island smart cities requires a profound organizational transformation. The adoption of a business innovation management mindset allows for the coupling of digital ecosystems and business innovation in a single ecosystem framework. For island cities, this approach is not just a strategic choice, but a structural necessity to achieve sustainable and resilient growth.

From a policy perspective, the findings suggest that urban authorities should prioritize ecosystem-based governance models, invest in interoperable digital infrastructures, and foster public–private collaboration. Future research could empirically test the proposed framework across different island contexts and examine its applicability in non-island urban environments.

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