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Deliverable D4.3 - *[Guidelines for transferability of successful instruments from other policy areas to climate change adaptation]*

WP4 – [Roadmap for policy transformational change]

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HORIZON-MISS-2021-CLIMA-02-05 - Local engagement of citizens in the co-creation of societal transformational change for climate resilience

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Document History

Deliverable Title	Deliverable D4.3 – Guidelines for transferability of successful instruments from other policy areas to climate change adaptation
Brief Description	The deliverable D4.3 identifies participatory elements in digitalization policies and evaluates their applicability to climate change adaptation, offering guidelines for transferring these tools to climate adaptation policies. It highlights digital participation, discussing its advantages and limitations to justify the focus on digitalization policies aimed at fostering citizen engagement.
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Lead Beneficiary	IIASA
Author(s)	Nadejda Komendantova, Dmitry Erokhin, Peyman Arjomandi Akram, Abraham Yosipof, Tahereh Zobeidi, Anna Scolobig, Enora Bruley
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1. Executive summary

Deliverable 4.3 explores the transferability of successful citizen and stakeholder engagement instruments from digitalization to climate change adaptation policies. Digitisation is used as a point of reference because its tools and approaches have proven effective in enabling broad, inclusive, and transparent engagement – qualities that are crucial for successful climate adaptation.

Digitalization policies provide a foundation for inclusive and transparent stakeholder engagement through advanced tools and public-private collaborations. This report evaluates these mechanisms by examining key participatory elements such as stakeholder involvement, engagement methods, funding strategies, transparency measures, and feedback systems. The analysis offers guidelines for adapting these mechanisms to enhance citizen involvement in climate change adaptation policies (see Fig. 1 for an overview of notable mechanisms to promote participation).

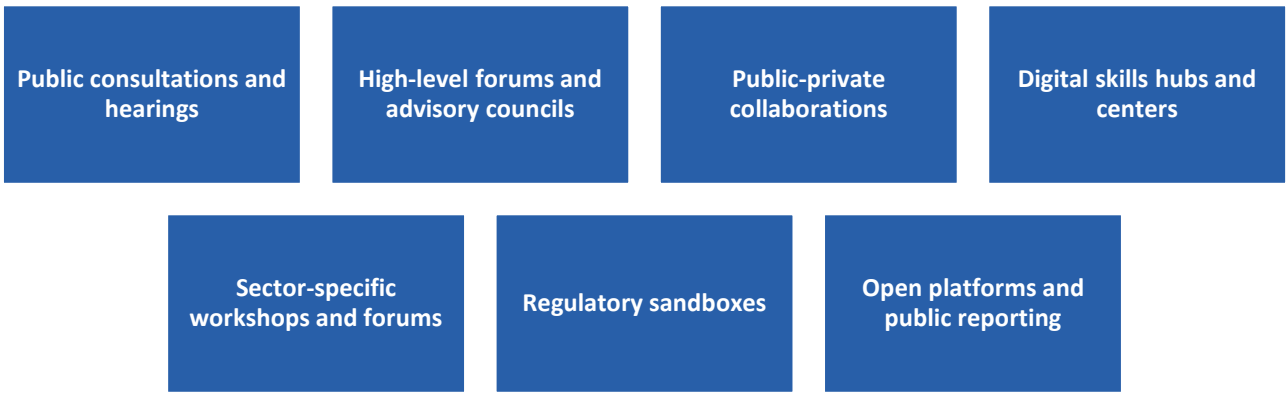

Figure 1: Notable mechanisms to promote participation

Some notable mechanisms that promote participation in the reviewed digitalization policies include:

- **Public consultations and hearings**: Structured processes for gathering opinions and suggestions from citizens and organizations, often mandated by specific laws.
- **High-level forums and advisory councils**: Platforms for sectoral consultations in specific industries and sectors.
- **Public-private collaborations**: Emphasized across various policies to involve private entities and foster joint initiatives.
- **Digital skills hubs and centres**: Public-private institutional bodies for dialogue, training, and coordination, ensuring inclusivity for all stakeholders.
- **Sector-specific workshops and forums**: Dialogue mechanisms tailored for industries to identify their needs and potentials.

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- **Regulatory sandboxes**: Controlled environments for testing innovations under flexible regulations to engage multiple stakeholders.
- **Open platforms and public reporting**: Platforms for collaborative discussions and feedback, alongside transparent public reporting.

These mechanisms not only enhance inclusivity but also ensure that diverse perspectives contribute to shaping policies and strategies effectively. The report's guidelines emphasize **digitally-enabled approaches** to strengthen participation and transparency in climate adaptation because digital tools can overcome traditional barriers to engagement, such as geographic distance, limited access to information, and social exclusion. By leveraging technology, a **wider range of stakeholders** including those in remote or marginalized communities can be involved in decision-making processes, ensuring that adaptation strategies are **more representative, equitable, and effective**.

They advocate the use of **digital platforms for inclusive engagement** (e.g., mobile apps and online forums) to broaden stakeholder input and reach marginalized groups, alongside **open data portals** that ensure transparent access to climate information and resources. The guidelines also recommend **interactive feedback tools** such as online surveys and collaborative comment platforms and **real-time monitoring mechanisms** that allow continuous stakeholder input and adaptive tracking of progress. To support these innovations, **digital literacy programs** are highlighted to empower citizens and officials with the skills to participate effectively via technology. **Together, these digitally-enabled recommendations foster broader inclusion, transparency, and responsiveness** in climate change adaptation efforts.

2. Introduction

2.1 Project overview

The EU-funded Horizon Europe project **Adaptation AGORA – A Gathering place to cO-design and co-cReate Adaptation**, part of the Mission on Adaptation to Climate Change, is focused on strengthening community and regional resilience by engaging citizens and stakeholders in climate adaptation decision-making. Adaptation AGORA emphasizes co-designing and implementing locally tailored solutions, drawing on best practices for engaging diverse voices.

Adaptation AGORA also serves as a hub for knowledge exchange, connecting communities, experts, and policymakers to advance effective climate adaptation. Pilot regions in Germany, Sweden, Spain, and Italy are central to the project, acting as arenas where climate solutions are co-created with local actors. These efforts aim to produce a roadmap for enduring climate resilience, citizen engagement, and supportive policies. Ultimately, Adaptation AGORA aspires to build a strong, engaged community committed to positive climate action and a resilient future.

This deliverable (D4.3) contributes to the Adaptation AGORA's objectives by providing guidelines on transferring successful participatory instruments from digitalization to climate change adaptation

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policies. Through an in-depth evaluation of digital participation's strengths and limitations, it offers a framework for adapting these tools to foster citizen engagement in climate change adaptation. This deliverable supports Adaptation AGORA's mission by expanding the toolkit for community-centred adaptation, enhancing the project's ability to drive effective and inclusive climate action.

2.2 Aim

This deliverable (D4.3) presents guidelines for adapting participatory instruments from digitalization policies to climate change adaptation, drawing upon the findings collected in Task 4.3 (see Box 1).

Task 4.3: Evaluate the transferability of instruments and experiences from other policy areas

The aim of this task is to compare and contrast citizen engagement/co-production policy instruments (e.g. regulations, voluntary and mandatory instruments, financial incentives, infrastructures and technologies, data sharing tools, etc.) used in other policy areas, including e.g. the digital and energy/climate mitigation sector. The task will also include an evaluation of the potential for the instrument`s transferability in climate change adaptation policies. Specific attention will be dedicated to the role of the private sector and of public-private partnerships to engage citizens in the implementation of innovative climate adaptation solutions. Using methods of comparative policy research, guidelines for the implementation of different instruments will be developed.

Box 1: Task 4.3 description

By analysing successful participatory mechanisms employed in various digitalization frameworks, the report aims to identify transferable strategies that can be effectively utilized in the context of climate change adaptation (see Fig. 2). Moreover, it examines strengths and limitations of digital participation. Through a comprehensive evaluation of existing policies and participatory practices, the report provides actionable guidelines and a framework for implementing these tools, ultimately supporting the Adaptation AGORA project's mission to empower communities and promote sustainable development in the face of climate change.

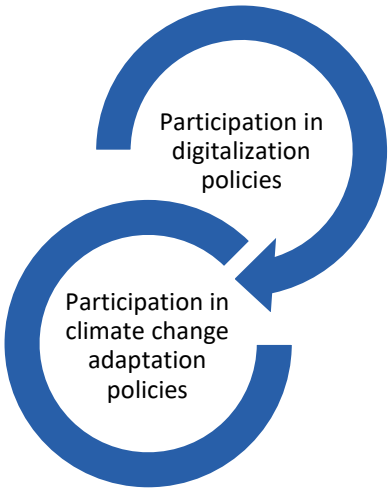

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Figure 2: Aim of Task 4.3

2.3 Structure of the report

Section 3 reviews the concept of digital participation, examining its advantages and disadvantages, while also drawing comparisons to traditional on-site participation. Section 4 outlines the methodology employed in the report. Section 5 presents the analysis of participatory elements found within digitalization policies. Section 6 evaluates the feasibility of transferring these participatory elements from digitalization policies to climate change adaptation policies. Section 7 provides a set of guidelines for effectively transferring participatory elements. Section 8 presents two original case studies conducted by the authors and demonstrates how evidence from disaster response and science communication can inform D4.3's guidelines on using digital tools for participatory adaptation. Section 9 concludes the report.

3. Digital participation

Digitalization policies are selected for the analysis because they inherently promote digital participation, which provides a model for inclusive and transparent citizen engagement in policymaking. These policies play a significant role in advancing participatory democracy by facilitating tools that allow for broad, accessible citizen involvement.

Digital participation has emerged as a significant area of research and practice, leveraging information and communication technologies to enhance citizen engagement in public policymaking (Loukis et al., 2012). It encompasses various mechanisms for citizen engagement in policy-making and public services design. These range from structured e-forums and social media platforms moderated by government agencies (Loukis, 2012) to citizen-initiated interactions (Meijer et al., 2009).

The origins of digital participation can be traced to the late 20th and early 21st centuries, as internet connectivity became widespread and offered new opportunities for civic engagement (Milakovich, 2010). Over the past two decades, governments, civil society organizations, and international bodies have increasingly recognized the potential of digital technologies to facilitate participation. E-democracy initiatives (Kumar, 2017), participatory budgeting platforms (Gordon et al., 2017), and civic technology projects (Shiramatsu et al., 2015) demonstrate how digital participation has evolved from a supplementary tool to an essential component of democratic engagement. The COVID-19 pandemic accelerated the adoption of digital tools for citizen engagement (European Parliament, 2022).

Digital participation carries both advantages and disadvantages, which are discussed further below (see Table 1 as a summary of sections 3.1 and 3.2).

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Advantages of digital participation	Disadvantages of digital participation
•Enhanced accessibility •Broader participation •Reduced barriers (geographical distance, mobility, time) •Fostered inclusivity •Marginalized voices amplification •Diverse group engagement •Efficiency in input collection •Quick feedback and response •Automated data collection and analysis •Greater transparency •Accountability and trust building •Innovative interactive experiences •Continuous engagement	•Digital divide •Uneven access to technology •Socioeconomic and geographical disparities •Quality of engagement concerns •Lack of context or understanding •Anonymity and toxic behavior •Privacy and security risks •Data protection concerns •Vulnerability to hacking and manipulation •Risk of mis- and disinformation •Potential for superficial engagement •Risk of tokenism over genuine involvement

Table 1: Advantages and disadvantages of digital participation

3.1 Advantages of digital participation

One of the key advantages of digital participation is its ability to enhance accessibility (Hovik et al., 2022). Digital platforms enable broader participation by reducing barriers such as geographical distance, physical mobility limitations, and time constraints. This accessibility allows individuals who might not be able to attend a physical meeting to participate online at their convenience.

Another advantage of digital participation is its potential to foster inclusivity (Davis & Farmer, 2016). Digital platforms can amplify the voices of those who are often marginalized in traditional settings. Online platforms facilitate the engagement of diverse groups in public discourse, helping to broaden the range of perspectives and inputs.

Efficiency is another important advantage. Digital tools streamline the collection of input and feedback, enabling quicker responses from both participants and decision-makers. Automated data collection and analysis tools also help organize and assess large-scale public input, making the participatory process more efficient (Mahyar et al., 2019).

Digital platforms also offer greater transparency in decision-making (Zhao et al., 2023). These platforms can provide a public record of discussions, votes, and decisions, fostering greater accountability and trust between the public and governing institutions. The digital environment further encourages innovation in participation (Salter et al., 2009), offering interactive experiences such as simulations, visualizations, and real-time collaborations that are difficult to replicate in face-to-face settings. This enables continuous engagement, rather than relying on sporadic in-person events.

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3.2 Challenges and disadvantages of digital participation

Despite its advantages, digital participation is not without its challenges. One of the primary concerns is the digital divide (Frey et al., 2024; Davis et al., 2017). Not everyone has equal access to digital technologies, and disparities in internet access, technological literacy, and availability of digital tools can result in uneven participation. Socioeconomically disadvantaged populations or those living in rural areas may find it difficult to engage in digital participation, which risks excluding certain groups from the process.

Another challenge is the quality of engagement (Farina et al., 2014). Digital platforms can sometimes foster lower-quality contributions. Participants may lack the necessary context or understanding to contribute meaningfully to complex discussions, and the anonymity that online platforms often provide can encourage toxic or offensive behaviours (Lapidot-Lefler & Barak, 2012) or untruthful contributions, detracting from the constructive nature of the discourse.

Privacy and security concerns also present significant challenges (Ahangama, 2023; Hoffmann & Lutz, 2023; Skaržauskienė et al., 2014). The collection and storage of personal data on digital platforms raise concerns about privacy and data protection. If participants do not trust that their data will be safeguarded, they may be less inclined to engage. Furthermore, digital platforms are vulnerable to hacking, manipulation, and disinformation, which can undermine the integrity of the participatory process.

Another disadvantage is the potential for superficial engagement (Davies & Procter, 2020; Levenda et al., 2020). While digital platforms enable rapid responses, they can also result in shallow participation. Clicking a button in an online poll or making a brief comment in a forum may not lead to sustained engagement or deep deliberation. Critics argue that digital participation, when not carefully designed, can become more about tokenism than genuine involvement in the decision-making process.

3.3 Digital participation vs. on-site participation

Digital participation also has its pros and cons in comparison to on-site participation, as discussed below (see Table 2 as a summary of sections 3.3).

Aspect	Digital participation	On-site participation
Reach	Broad, allowing participants from various locations	Limited to those who can physically attend
Diversity of input	Higher potential diversity due to accessibility	Potentially less diverse, depending on location and accessibility
Interaction	Limited face-to-face interaction, often missing non-verbal cues	Direct face-to-face interaction, including non-verbal communication

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Depth of deliberation	May lack spontaneity and nuanced discussion; often more structured	Allows for spontaneous dialogue, debate, and real-time clarification
Anonymity	Can allow anonymous contributions, enhance inclusivity but reduce accountability	Usually requires identifiable participants, increasing accountability but may discourage dissent
Convenience/Time commitment	More flexible timing: participants can join and contribute at their convenience	Fixed timing, requiring participants to be present in real-time
Sense of engagement	May feel less personal or engaging due to remote nature	Creates a stronger sense of involvement through physical presence
Technical requirements	Requires access to technology and stable internet	Requires physical travel and venue space
Environmental impact	Lower travel and resource footprint, more eco-friendly	Higher environmental impact due to travel and venue requirements
Institutional/political impact	If anonymous, it may reduce legitimacy	It may increase accountability and legitimacy

Table 2: Comparison of digital and on-site participation

When comparing digital participation to traditional, non-digital on-site participation, important distinctions arise. Digital participation generally has a broader reach, allowing individuals from different geographic locations to contribute (Thoneick, 2021; Pietilä et al., 2019). In contrast, on-site participation is limited to those who can physically attend an event, which can result in less diverse inputs. However, on-site participation allows for direct, face-to-face interaction, which can foster deeper connections among participants and create a stronger sense of involvement (Balaguer & Gifreu-Castells, 2023). Moreover, digital participation offers greater flexibility in terms of timing. Participants are more flexible with timing in online participation, whereas on-site participation usually requires a fixed time commitment, which can limit the number of attendees but may also create a more dedicated and focused environment

Another distinction lies in the depth of deliberation and engagement. In traditional, in-person settings, participants often engage in more nuanced discussions, with opportunities for spontaneous dialogue, debate, clarification, and learning (Garces et al., 2024; Seitz, 2016). Non-verbal cues such as body language and tone of voice play an important role in these interactions. Digital platforms, on the other hand, may not provide the same opportunities for real-time, detailed deliberation, which can affect the quality of engagement.

A further difference is the level of anonymity (Forestal & Philips, 2020; Perbawani et al., 2018; Brock et al., 2005). Digital platforms often allow for anonymous participation, which can both democratize the process and result in a lack of accountability. On-site participation typically requires participants

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to be physically present and identifiable, which can encourage accountability but may also discourage individuals from expressing dissenting or controversial opinions.

To summarize the insights regarding when digital versus in-person participation is most appropriate, digital participation proves especially useful when the aim is to collect broad-based opinions or engage large and diverse audiences quickly and cost-effectively. Studies show that online participation is well-suited for activities such as expressing opinions on policy directions, responding to consultations, and engaging in low-barrier actions like signing petitions or commenting on proposals (Oser et al., 2022; Tai et al., 2019; Vissers et al., 2012). Furthermore, digital platforms can foster engagement among underrepresented groups and even stimulate subsequent offline involvement. In contrast, offline participation is generally more effective for deliberative processes requiring deep discussion, mutual understanding, and collective problem-solving. Empirical evidence from participatory budgeting and urban planning shows that in-person formats lead to more representative and deliberative outcomes, making them ideal for complex or localized decisions (Lim & Oh, 2016; Thoneick, 2021). Moreover, face-to-face mobilization has a stronger influence on actual offline civic behaviour than digital outreach (Vissers et al., 2012). Recent literature also suggests hybrid approaches combining digital outreach with in-person deliberation can address the limitations of both formats. Such models (Itten & Mouter, 2022); Zhang, 2022) enable mass engagement while preserving the quality of small group deliberation.

3.4 Psychological drivers of participation in climate adaptation policies

Participation in climate change adaptation policies is intricately linked to individuals' psychological determinants (Drews & Van den Bergh, 2016). While concern about climate risks and coping mechanisms serves as a primary motivator, specific psychological factors significantly influence the mode and extent of individual participation intention. For instance, individuals with strong ecocentric values (Thompson & Barton, 1994) – prioritizing the intrinsic worth of nature – are more inclined to engage through digital platforms, aiming to reduce their travel and resource footprints. This preference aligns with findings that ecocentric identities often manifest in online environmental activism, where digital engagement is perceived as both effective and environmentally responsible (Hannouch & Milstein, 2025).

Even more, social norms play a pivotal role in shaping participation behaviors. The presence and influence of peers or significant others can motivate individuals to prefer attendance in climate policy deliberations (Lo, 2013; Doherty & Webler, 2016). Research indicates that perceived social norms – beliefs about the expectations and behaviors of others – are strong predictors of climate change discussions and actions (Yu et al., 2019). The desire to align with group expectations or to be part of a collective effort often drives individuals toward in-person engagement (Steenberghs et al., 2021).

Based on insights into climate policy support, a study conducted within the scope of this project (unpublished, forthcoming) incorporated concepts from two socio-psychological models: the Risk

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Perception Attitude (RPA) Framework (Rimal & Real, 2003) and the Extended Parallel Process Model (EPPM) (Witte, 1992). The RPA Framework categorizes individuals based on their perceived risk and efficacy beliefs, influencing their responsiveness to health and climate change communications (e.g., Koh, 2023; Paek & Hove, 2024). The EPPM, on the other hand, explains how individuals respond to fear appeals, balancing perceived threats with perceived efficacy to determine adaptive responses (Tsoy et al., 2022).

The study's findings revealed that, beyond the primary factors of risk and coping appraisals outlined in these models, elements such as ecocentric values, social norms, and climate change skepticism (Engels et al., 2013) – doubt about the severity or causes of climate change – significantly affect participation in climate change policy formulation.

These insights endorse the adoption of hybrid approaches that combine digital outreach with in-person deliberations. While hybrid strategies are shown to be effective in broadening engagement, the primary focus of this deliverable remains on digital participation mechanisms because they offer scalable, cost-effective, and innovative solutions that can reach wider and often underserved audiences. Digital approaches are emphasized to accelerate the transformation toward more transparent, accessible, and adaptive climate adaptation processes. However, this emphasis does not dismiss the value of in-person engagement, but rather highlights the unique advantages of digital methods in expanding reach and responsiveness, particularly in resource-constrained or geographically dispersed contexts.

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4. Methods

The methodology of the analysis of participatory elements in digitalization policies included criteria-based analysis to assess stakeholder involvement, participatory mechanisms, transparency, and monitoring. This was complemented by content analysis using AI tools to extract relevant insights from policy documents, ensuring a comprehensive evaluation. Empirical data collection relied on policy databases across Spain, Germany, and the EU, encompassing diverse perspectives and contextual nuances. To ensure rigor and reliability, the AI-collected insights were thoroughly reviewed and verified by the authors, leveraging human researchers' expertise to validate findings and maintain the analysis's credibility and accuracy.

4.1 Policy identification and selection

For Spain, the report relies on the policies listed by the Digital Spain Agenda (Government of Spain, 2025), for Germany – the German Digital Technologies website (Forum Digital Technologies, 2023), and for the EU – the relevant webpage of the European Commission on digitalization policies (European Commission, 2025). These official webpages allowed for creating a comprehensive list of policies. In total, 9 Spanish policies, 17 German policies, and 10 EU policies were identified (see Table 3).

EU
Digital Decade Policy Programme 2030 – 2022
EU Code of Practice on Disinformation – 2022
EU Cybersecurity Strategy – 2020
A European Strategy for a Better Internet for Kids (BIK+) – 2022
Coordinated Plan on Artificial Intelligence – 2021
A European Strategy for Data – 2020
Sustainable and Smart Mobility Strategy – 2020
Digital Education Action Plan (2021-2027) – 2020
Digital Markets Act – 2022
Digital Services Act – 2022
Germany

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Action Plan for Artificial Intelligence – 2023
Progress through Data Utilization – 2023
Strategy Paper Robotics and Automation 2028: Key Technology for Germany – 2023
Strategy on China – 2023
Integrated Security for Germany – National Security Strategy – 2023
Future Research and Innovation Strategy – 2023
Digital Strategy of Germany – 2022
Startup Strategy of the Federal Government – 2022
Gigabit Strategy of the German Government – 2022
Cybersecurity Strategy for Germany – 2021
Open Data Strategy of the German Federal Government – 2021
German Sustainable Finance Strategy – 2021
German Sustainable Development Strategy – 2021
Data Strategy of the German Federal Government – 2021
Roadmap Quantum Technology – 2021
Update of the German AI Strategy 2020 – 2020
Digital Agenda for Environmental Policy – 2020
Spain
Recovery, Transformation and Resilience Plan – 2021
Digital Spain 2026 – 2020
National Artificial Intelligence Strategy – 2020
The Digital Infrastructures and Connectivity Plan for Society, Economy and the Territories – 2020
Strategy for the Promotion of 5G Technology – 2020

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National Plan for Digital Skills – 2021
Plan for the Digitalization of Spain's Public Administration: 2021-2025 – 2021
SMEs Digitalization Plan 2021-2025 – 2021
Spain Audiovisual Hub – 2021

Table 3: Selected EU, German, and Spanish digitalization policies

This methodical selection process minimized the risk of bias or omissions, ensuring that the analysis was grounded in a well-documented and authoritative dataset. By focusing on official platforms, the methodology provided a reliable and standardized framework for identifying relevant policies across different contexts. This consistency not only enhanced the comparability of the policies but also supported the credibility and replicability of the findings. The reliance on official sources further ensured that the analysis reflected current and widely recognized policy frameworks within the respective countries and regions.

4.2 Policy analysis

4.2.1 Criteria based analysis

The policies were analysed based on the participatory criteria established in task 4.2 (see Deliverable 4.2 "Policy Instruments and Influences on Co-Production" for more details). Specific groups of stakeholders involved in participation, participatory mechanisms, nature of participation, funding, capacity building, transparency and information sharing as well as monitoring and feedback were considered. The elements were first identified and then their potential application to participation in climate change adaptation was analysed.

4.2.2 Content analysis

The content analysis for this study was conducted in a manner consistent with the methodology outlined in the Deliverable 4.2 of the AGORA project. Specifically, a Large Language Model (LLM) Artificial Intelligence (AI) tool, Copula AI, was employed to extract relevant information from the selected digitalization policies. This approach leveraged the dynamic capabilities of LLMs to identify and extract pertinent words, phrases, and topics, transcending the limitations of predefined keywords and enhancing the comprehensiveness of the analysis.

Copula AI utilizes vector similarity search (Long et al., 2024; Riyadh, 2024) to align queries and documents within a mathematical space, identifying the most relevant sections of a text – typically spanning approximately seven pages. These sections are then used in a Retrieval-Augmented Generation (RAG) process, where the LLM generates answers grounded in the retrieved document content, minimizing hallucinations and ensuring accuracy. By implementing this system, the analysis achieved greater efficiency and flexibility compared to traditional deductive coding, without compromising the rigor of the findings.

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Pre-identified criteria guided the analysis of each policy document. For instance, the stakeholder groups addressed by participatory elements in digitalization policies were systematically examined. The process involved Copula AI transforming both the query and document text into vectors, calculating their alignment through vector similarity, and retrieving the most relevant sections. The retrieved content formed the basis for generating answers, which were verified for transparency by presenting the extracted sections to the human researchers for review.

To ensure compliance with ethical standards and GDPR, the methodology excluded personal data from processing. Additionally, a dual-validation approach combined automated insights from the LLM AI tool with critical review by human researchers. This collaboration between advanced technology and expert evaluation established a robust, transparent, and reliable framework for analysing policy data. Further details on this methodology can be found in the Deliverable 4.2.

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5. Policy analysis

This section identifies and discusses the participatory elements embedded within digitalization policies, focusing on their design, implementation, and operational characteristics. The analysis covers key aspects such as stakeholder involvement, participatory mechanisms, transparency, capacity building, and monitoring frameworks. By exploring these dimensions, the section provides insights into the ways digitalization policies have structured and facilitated participatory processes.

The evaluation highlights the diversity of mechanisms and stakeholder groups involved, along with the approaches used to ensure inclusivity, transparency, and accountability. Through a systematic examination of these elements, this section aims to provide a comprehensive overview of how participatory practices are integrated into digitalization policies, serving as a foundation for further analysis.

The resulting typology clusters participatory elements along three transversal dimensions. Depth / obligation asks how binding a given engagement mechanism is. Temporal purpose situates each mechanism in the policy cycle whether it serves consultation and agenda-setting, co-creation and implementation, or monitoring and evaluation. Finally, actor constellations capture who participates and in what roles. These dimensions align with Sections 5.1–5.7: 5.1 details the actor constellation, 5.2–5.4 spell out mechanism types together with their binding strength, and the temporal purpose informs capacity-building in 5.5 (preparatory stage), transparency and information sharing in 5.6 (concurrent stage), and monitoring and feedback in 5.7 (ex-post stage).

5.1 Stakeholders involved in participation

The participatory elements of digitalization policies involve diverse stakeholder groups across multiple dimensions (see Fig. 3). This typology categorizes stakeholders based on their societal roles and actor constellations – a dimension focused on who participates in digitalization policy processes. Stakeholders are grouped into seven clusters (e.g., citizens, businesses, governments) to reflect their distinct interests and capacities in shaping policies. The logic prioritizes inclusivity and representation across sectors, distinguishing groups by their functional relationship to digitalization (e.g., vulnerable populations needing tailored support vs. private sector actors driving innovation). While roles may overlap, the classification emphasizes primary objectives: ensuring marginalized voices are heard (e.g., elderly, disabled), aligning industry expertise, and leveraging institutional authority. This actor-centric approach ensures broad representation while clarifying stakeholder responsibilities within participatory frameworks.

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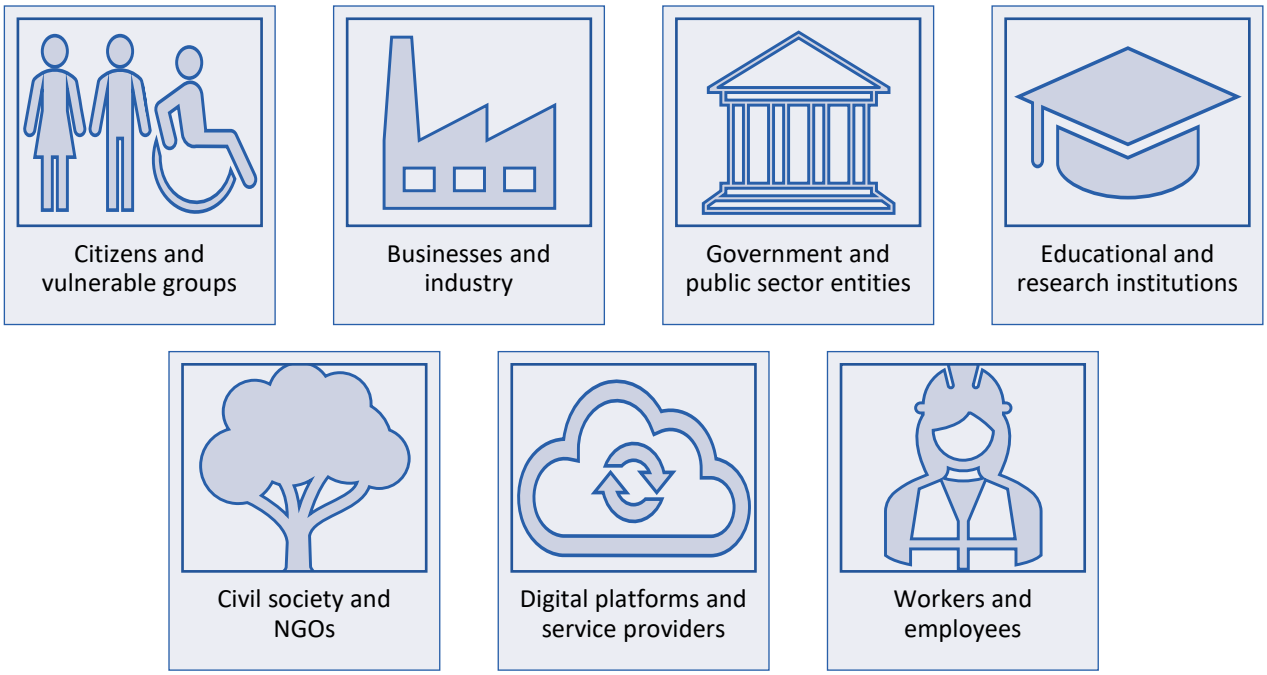

Figure 3: Stakeholders in digitalization policies

Digitalization policies engage diverse stakeholder groups across multiple dimensions to ensure broad representation and inclusivity in policy-making processes (see Fig. 3).

- **Citizens and vulnerable populations** include the general public, consumers, and specifically targeting marginalized or at-risk groups such as the elderly, women, girls, persons with disabilities, children, adolescents, the long-term unemployed, and other communities needing support. For instance, Digital Spain 2026 aims to enhance digital skills for the elderly and unemployed.
- **Businesses and industry** encompass a wide array from small and medium-sized enterprises (SMEs) and micro-enterprises to start-ups, self-employed individuals, industry representatives, private sector entities, technology providers, content creators, telecom operators, equipment manufacturers, investors, and sector-specific businesses like clean-tech industries. A notable example is Spain's SMEs Digitalisation Plan, which specifically targets SMEs and the self-employed.
- **Government and public sector entities** include federal, state, and local government agencies, ministries, municipalities, central and regional administrations, alongside EU-level institutions like the European Commission, Parliament, and Council. This category also covers digital service coordinators, national defence forces, advisory councils, cybersecurity agencies, and economic/social agents. Germany's Cyber Security Strategy underscores coordination across governmental levels, while Spain's Plan for the Digitalisation of Public Administration involves various ministries and administrative bodies.

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- **Educational and research institutions** include universities, research centres, schools, and vocational training centres, along with researchers, students, and teaching staff, all vital for advancing digital skills and innovation. Germany's AI Strategy actively involves universities and research centres, and the EU's Coordinated Plan on Artificial Intelligence views them as essential for building AI capacity.
- **Civil society organizations and NGOs** involve non-governmental organizations, trade unions, social partners, employer organizations, media literacy experts, and groups addressing disinformation. These actors play a critical role in representing diverse social interests. The EU's Code of Practice on Disinformation acknowledges civil society's role, and Spain's National Plan for Digital Skills collaborates with NGOs and unions.
- **Digital platforms and service providers** include telecommunications operators, gatekeepers (large online platforms), online platform providers, video-sharing platforms, data intermediation services, and IT security providers. The EU's Digital Services Act (DSA) directly engages these platforms, mandating responsible practices. The seventh group encompasses **workers and employees** across sectors such as transport, public administration, SMEs, and those involved in the green transition, ensuring labour concerns are addressed.

5.2 Participatory mechanisms

Several key mechanisms facilitate stakeholder engagement in digitalization policies (see Fig. 4). Mechanisms are classified by their structural form and function, grouping hubs, observatories, and other tools under specialized collaborative environments. While hubs (action-oriented innovation spaces) and observatories (monitoring/data repositories) differ in temporal purpose (concurrent vs. ex-post stages), they share a common structural role: formalizing stakeholder collaboration through dedicated platforms. The typology prioritizes mechanism design over temporal alignment, distinguishing six categories (e.g., consultations, advisory councils) based on how engagement is institutionalized. This approach balances functional diversity (e.g., hackathons for youth vs. task forces for experts) with structural coherence, ensuring mechanisms are adaptable to varied policy goals while maintaining clarity in implementation.

- **Public consultations and online engagements** include structured public and preliminary consultations, hearings, online platforms, and dialogues designed to gather broad input. For example, Spain's Recovery, Transformation, and Resilience Plan utilized extensive online consultations.
- **Social dialogue, forums, and conferences** encompass sectoral conferences, dialogue forums, social dialogues involving social partners, expert panels, roundtables, and both national and international forums that foster discussion and collaboration. For example, Germany's Digital Strategy employs multi-stakeholder dialogues.
- **Advisory councils, committees, working groups, and task forces** provide targeted advice and coordinate actions among stakeholders. Spain's Plan for the Digitalisation of Public

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Administration, for instance, uses expert groups, while the EU's Code of Practice on Disinformation established a Permanent Task Force involving diverse stakeholders.

- **Public-private partnerships and collaborative mechanisms** formalize collaborations between public institutions and private entities to execute plans and pool resources. Germany's Digital Spain 2026 explicitly encourages such partnerships for investment coordination.
- **Specialized hubs, labs, innovation platforms, and observatories** include digital skills hubs, innovation labs, civic innovation platforms, AI platforms like the EU's AI-on-demand platform, and observatories designed to foster innovation and targeted stakeholder engagement. Spain's Audiovisual Hub plan aims to create specialized environments, and Germany's Environmental Digital Agenda includes Digital Innovation Hubs.
- **Youth participation and educational events** such as youth ambassadors, panels, hackathons, workshops, and educational events ensure that younger generations are involved in shaping policies that affect their digital future. Spain's National Plan for Digital Skills features youth-specific activities like hackathons, while the EU's Better Internet for Kids (BIK+) strategy focuses on empowering young people through consultations and literacy programs.

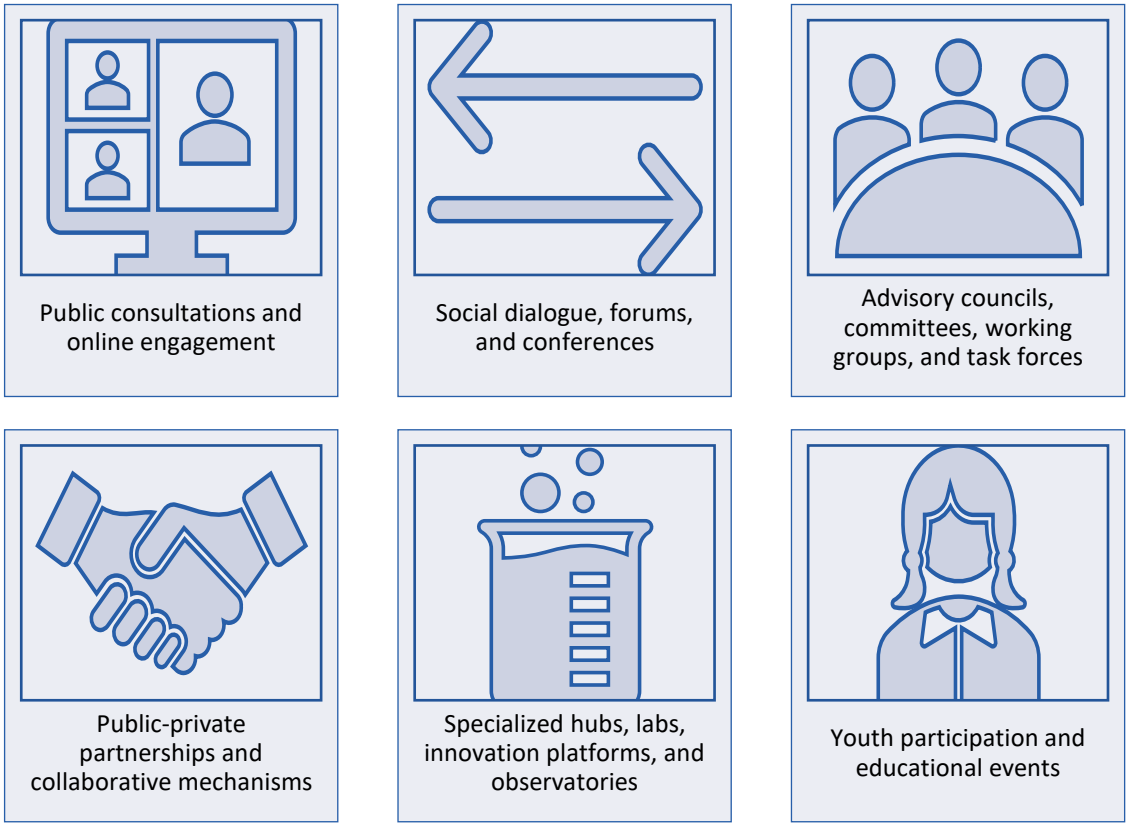

Figure 4: Consultation mechanisms in digitalization policies

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5.3 Nature of participatory mechanisms

The analysis identified three distinct types of participatory mechanisms (see Fig. 5). This typology hinges on depth of obligation, distinguishing mechanisms by their binding strength: mandatory (legally enforced), structured/non-binding (formal but voluntary), and voluntary (informal collaboration). The logic centres on power dynamics: mandatory mechanisms ensure compliance in high-stakes areas (e.g., cybersecurity), while non-binding tools balance flexibility with accountability. By categorizing based on enforceability, the framework clarifies how participation is incentivized, addressing tensions between legal rigor and open innovation. For example, mandatory consultations under the DSA contrast with voluntary SME partnerships, reflecting differing needs for regulatory control versus grassroots engagement.

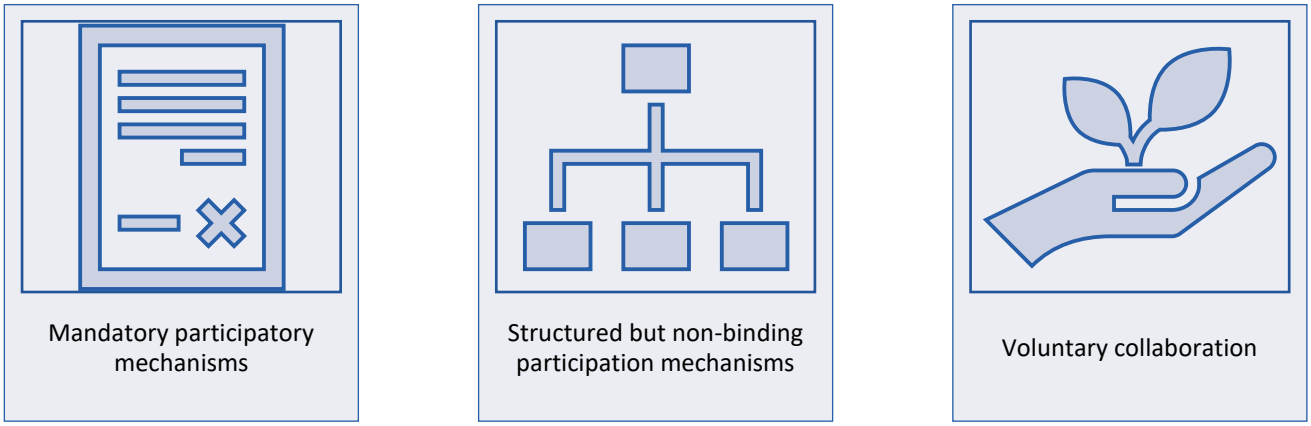

Figure 5: Type of participation in digitalization policies

- **Mandatory participatory mechanisms** are legally required forms of stakeholder engagement. These are often mandated by legislation or binding regulations, particularly in sensitive domains like data protection or the security of critical infrastructures. For example, the EU's Digital Services Act (DSA) imposes legally binding transparency and engagement obligations on digital platforms, and Germany's Cybersecurity Strategy outlines mandatory security requirements for critical infrastructure operators where stakeholder input is crucial for compliance.
- **Structured but non-binding participation mechanisms** are formal frameworks such as working groups, consultations, advisory councils, and forums that facilitate systematic stakeholder engagement without imposing legal obligations, thus offering flexibility. Germany's AI Strategy, for instance, utilized structured consultations and working groups to gather input without legal compulsion. Similarly, Spain's Connectivity Plan identifies structured dialogues that enable organized engagement without strict legal enforcement. While these mechanisms are structured, participation remains voluntary.
- **Voluntary collaboration** emphasizes open and informal participatory engagements. These mechanisms rely on stakeholders willingly engaging in collaborative efforts, partnerships,

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and ad-hoc activities without binding commitments. Spain's SMEs Digitalisation Plan, for example, encourages voluntary collaborations between SMEs and technology providers, while Germany's Environmental Digital Agenda supports voluntary initiatives in the field of digital environmental technologies, fostering a culture of open exchange.

5.4 Funding sources

The analysis reveals three main funding sources that support developments in the field of digitalization (see Fig. 6). Funding typology categorizes resources by origin and collaboration models: public (state/EU budgets), private (industry investments), and hybrid (public-private partnerships). While not exclusively participatory, these sources enable participation indirectly by resourcing capacity-building or innovation hubs.

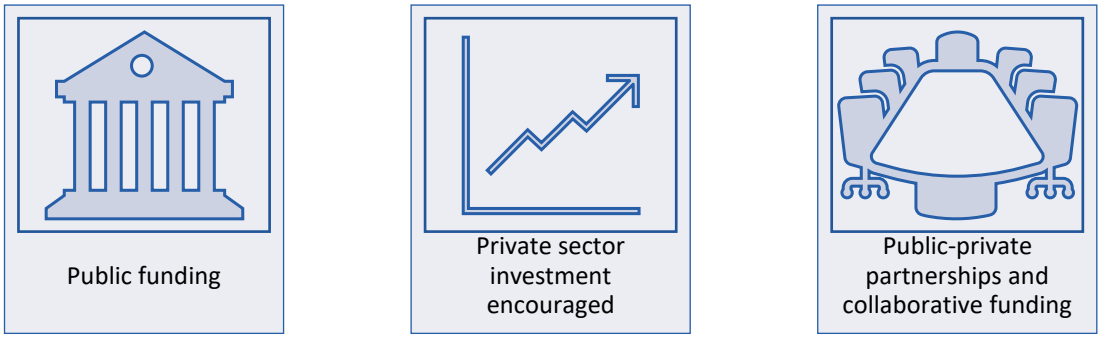

Figure 6: Funding sources in digitalization policies

- **Public funding** draws on financial support from national budgets and key EU programs such as the Recovery and Resilience Facility (RRF), Next Generation EU, Horizon Europe, and the Digital Europe Programme. These public funds are crucial for driving large-scale projects and policy initiatives. Spain's Digital Spain 2026 plan, for example, explicitly notes substantial public funding drawn from EU programs like the RRF, and Germany's Quantum Technology Action Concept highlights significant public investment in emerging technologies.
- **Encouraging private sector investment** involves creating regulatory and policy frameworks designed to actively promote private contributions, particularly in areas like research, development, innovation, and infrastructure projects. By leveraging private resources and expertise, this strategy complements public investments. For example, the EU's Digital Decade Policy Programme aims to create favourable environments for private capital.
- **Public-private partnerships and collaborative funding** involve co-financing arrangements and partnerships between public institutions and private entities, creating shared investment frameworks for key projects. Such collaborative approaches enable coordinated efforts and resource pooling. For example, Spain's Audiovisual Hub emphasizes attracting foreign investment through such models.

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5.5 Capacity building for participation

The analysis highlights several key areas for capacity building (see Fig. 7). Capacity-building measures are grouped by target groups and objectives: digital literacy (general public), public sector training, SME support, and institutional hubs. The typology reflects tailored strategies for empowering stakeholders to engage effectively. By aligning initiatives with stakeholder needs (e.g., cyber-skills for government staff vs. AI training for researchers), the framework ensures participation is not merely accessible but equitable, addressing disparities in technical readiness.

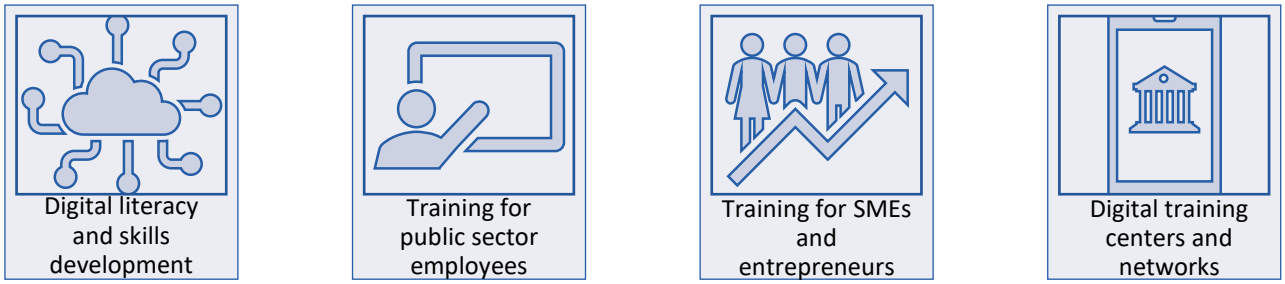

Figure 7: Capacity building in digitalization policies

- **Digital literacy and skills development** involve programs designed to improve digital competencies among the general population and specific stakeholder groups, incorporating initiatives such as media literacy training, specialized courses in emerging technologies, and youth engagement activities like fellowships, scholarships, hackathons, and summer academies. Spain's National Plan for Digital Skills, for instance, prioritizes digital literacy training for the public and marginalized groups, while the EU's BIK+ strategy outlines measures specifically for children and youth.
- **Training for public sector employees** aims to enhance the digital skills of government workers, equipping them to engage effectively in participatory processes and implement digital policies efficiently. Germany's Cybersecurity Strategy explicitly calls for enhancing the cyber literacy of public sector staff, a goal echoed in Spain's Digitalisation Plan for Public Administration which includes measures to upskill government workers.
- **Support and training for small and medium-sized enterprises and entrepreneurs** includes providing resources, guidance, and training tailored to enable these entities to participate in digital policy development and adopt relevant technologies, ensuring their inclusion in decision-making. Spain's SMEs Digitalisation Plan provides comprehensive training and guides specifically for SMEs, while the EU's Digital Markets Act aims to support SMEs' digital capacities.
- **Establishment of digital training centres and networks** offers accessible training and support to various stakeholders, facilitating their active participation in digital initiatives. The EU's Coordinated Plan on Artificial Intelligence promotes establishing networks like European Digital Innovation Hubs (EDIHs), and Germany's AI Strategy supports the creation of advanced AI training centres.

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5.6 Measures for transparency and information sharing

The analysis identifies several essential measures aimed at promoting transparency and information sharing to facilitate participation (see Fig. 8). Transparency mechanisms are categorized by purpose and format: open data platforms (accessibility), transparency tools (accountability), progress reporting (communication), guides (education), and ethical frameworks (trust-building). The logic centres on how information flows: from raw data (open portals) to actionable insights (best-practice guides). While formats vary, all aim to demystify policy processes, enabling informed participation.

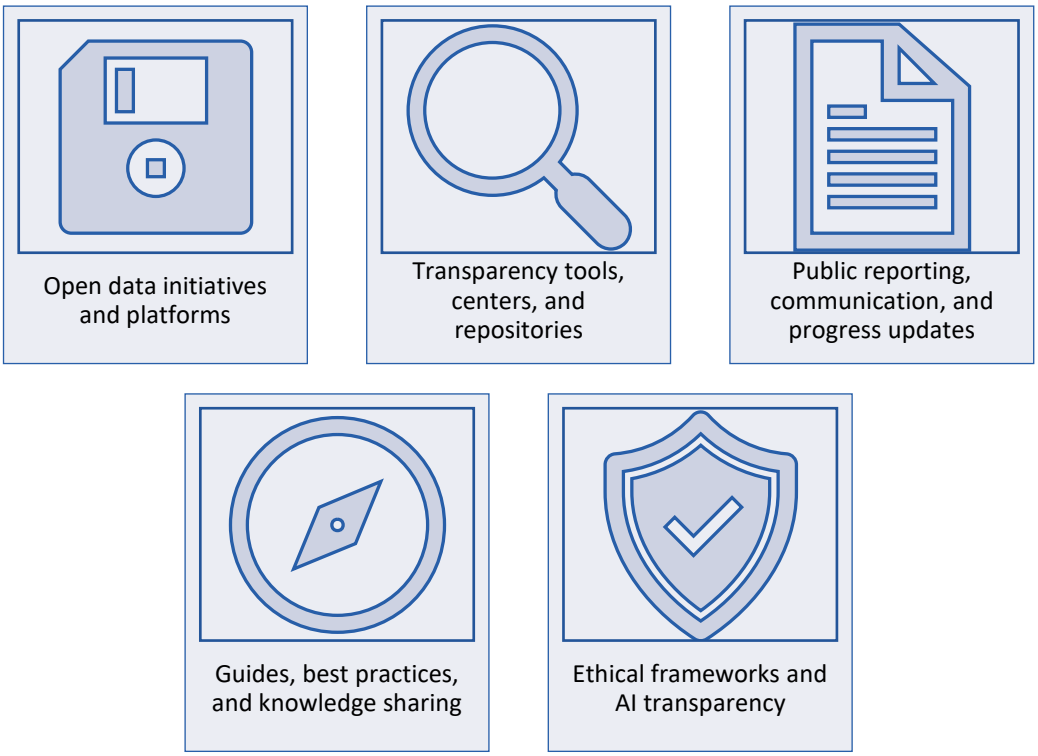

Figure 8: Transparency and information sharing in digitalization policies

- **Open data initiatives and platforms** focus on making government data accessible to the public, thereby fostering transparency, enabling innovation, and informing stakeholders for active participation. Germany's Data Strategy strongly emphasizes open government data, and Spain's Digital Spain 2026 includes open data portals, efforts complemented by the EU's Data Act framework.
- **Transparency tools, centres, and repositories** provide stakeholders with crucial access to policy information, data, and technological tools, enabling informed engagement. The EU's Code of Practice on Disinformation, for example, mandates Transparency Centres for political advertising, and Germany's Environmental Digital Agenda proposes a digital product passport for ecological transparency.
- **Public reporting, communication, and progress updates** regarding policy progress, implementation, and outcomes keep stakeholders informed and engaged, fostering

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accountability. Spain's Recovery, Transformation, and Resilience Plan includes comprehensive public communication and regular progress reports, while the EU's Digital Decade Policy Programme calls for transparent reporting across Member States.

- **Dissemination of guides, best practices, and knowledge sharing** better equips stakeholders to understand policies, participate effectively, and comply with requirements. For example, Spain's SMEs Digitalisation Plan mentions sharing digital transformation guides.
- **Ethical frameworks and AI transparency** include offering clear information on ethical guidelines, data governance models, and secure data management practices, which helps build trust and informs stakeholder participation, particularly concerning AI. The EU's Coordinated Plan on AI emphasizes establishing ethical guidelines, and Germany's AI Strategy calls for responsible, ethically guided AI development.

5.7 Monitoring and feedback mechanisms

The analysis outlines key monitoring and feedback mechanisms that incorporate stakeholder participation (see Fig. 9). These mechanisms are distinguished by their temporal alignment and stakeholder integration: feedback systems (ongoing input), monitoring bodies (oversight), and evaluation processes (post-hoc adjustment). The typology emphasizes iterative learning, with feedback loops enabling real-time adaptation, while ex-post evaluations ensure long-term accountability. By integrating stakeholders at all stages from participatory monitoring committees to impact assessments the framework ensures policies remain responsive and evidence-based, balancing flexibility with structured oversight.

Figure 9: Monitoring and feedback in digitalization policies

- **Stakeholder feedback systems** enable stakeholders to provide ongoing input on policies and their implementation through structured feedback loops, surveys, public comment periods, and platforms designed for co-creation and collaborative innovation. This fosters an inclusive approach to policy evaluation. Germany's Digital Strategy, for example, explicitly commits to continuous stakeholder engagement through regular feedback loops, and Digital Spain 2026 mentions using surveys and public comments for input.

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- **Monitoring bodies that include stakeholder participation** are tasked with oversight roles, ensuring that different perspectives are integrated into monitoring and evaluation processes. This inclusion enhances oversight robustness and promotes accountability. Spain's Connectivity Plan outlines monitoring committees that include various stakeholders, and the EU's Digital Services Act introduces EU-level oversight involving multiple stakeholders.
- **Evaluation and adjustment processes** are systematically utilized to assess policy impact. Based on this feedback, strategies and policies can be adjusted to improve effectiveness, ensuring they remain responsive to stakeholder needs and insights. The EU's Coordinated Plan on Artificial Intelligence, for instance, establishes periodic evaluations incorporating stakeholder feedback for policy refinement, and Germany's Data Strategy provides for regular evaluation and adjustment based on collected feedback.

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6. Policy transferability

The next step in this analysis involves exploring how digital participatory elements can be effectively applied to climate change adaptation. Drawing explicitly from the participatory elements already present in existing adaptation policies (as identified in D4.2), this section highlights the innovative aspects of digitalization that can enhance stakeholder engagement, transparency, capacity building, and monitoring in climate change adaptation.

6.1 Stakeholders involved in participation

Stakeholder involvement is crucial for successful policy transferability. Citizens and vulnerable groups are already widely acknowledged in adaptation policies due to their direct experience and local knowledge. **Innovative engagement methods** from digitalization, such as **digital platforms and real-time data sharing**, can significantly expand their participation (see Fig. 10). Similarly, while businesses and industries are standard stakeholders in adaptation, digitalization policies introduce novel ways to engage these actors through **interactive tools and data-driven collaborative mechanisms**.

Government and public sector entities traditionally coordinate and implement adaptation strategies. Digitalization adds innovative approaches, such as **enhanced digital transparency platforms**, allowing greater accessibility and accountability. Educational and research institutions remain vital, yet digital policies introduce new mechanisms such as **online innovation hubs**, enhancing knowledge dissemination and collaboration.

Civil society organizations and NGOs already advocate effectively for inclusive adaptation measures. **Digital tools**, however, offer innovative opportunities for amplifying local voices and facilitating real-time dialogue between communities and policymakers. **Digital platforms and service providers**, largely underutilized in adaptation policies, represent a particularly innovative element. Their expertise in data sharing and digital engagement significantly expands participatory possibilities.

Workers and employees contribute critical practical insights. Digital platforms enable **innovative real-time feedback and participation** from this group, ensuring policies are grounded in practical realities.

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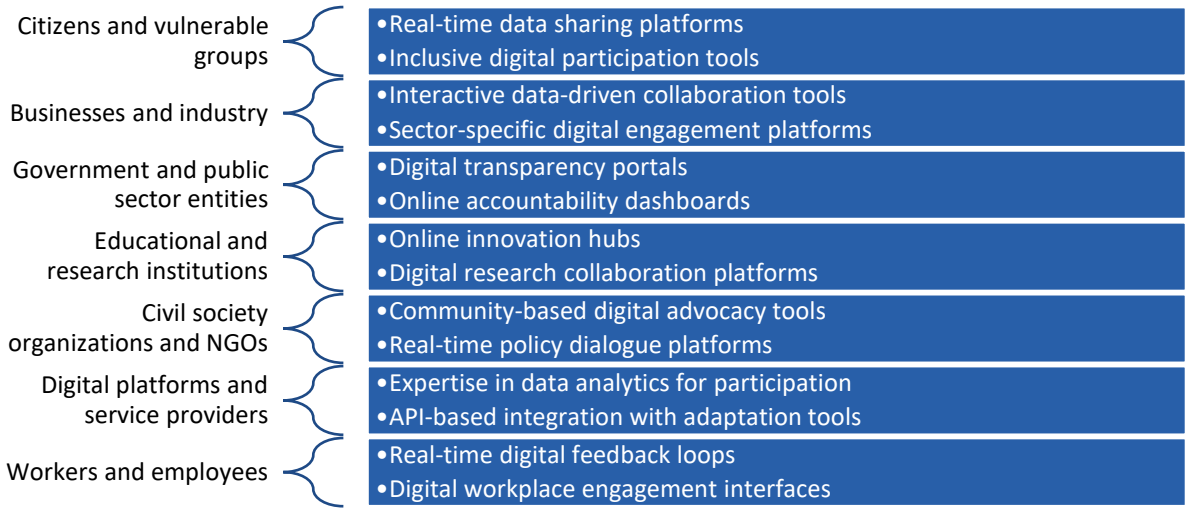

Figure 10: Enhanced stakeholder engagement in climate adaptation through digital innovations

6.2 Participatory mechanisms

Digitalization policies provide valuable innovative participatory consultation mechanisms (see Fig. 11). Public consultations and online engagements exist in adaptation policies. However, digitalization introduces enhanced **real-time online platforms and interactive tools**, significantly broadening accessibility and participation. Similarly, social dialogues, forums, and conferences are already standard, but digital innovations offer enhanced **virtual conference capabilities** and **sector-specific digital forums** that increase accessibility and effectiveness.

Advisory councils and task forces are common in adaptation, yet digital policies suggest innovative, **digitally supported expert networks and real-time advisory platforms**. Public-private partnerships are utilized in adaptation, but digitalization enhances this model through **data-driven collaborative platforms and co-financed digital infrastructure projects**.

Innovation hubs and observatories appear less frequently in adaptation. Transferring digital policy innovations such as **adaptation-focused digital innovation labs and citizen-driven monitoring observatories** represents a significant advancement. Youth participation, already recognized, benefits from innovative digital methods like **virtual hackathons and interactive digital education platforms**, significantly enhancing youth involvement.

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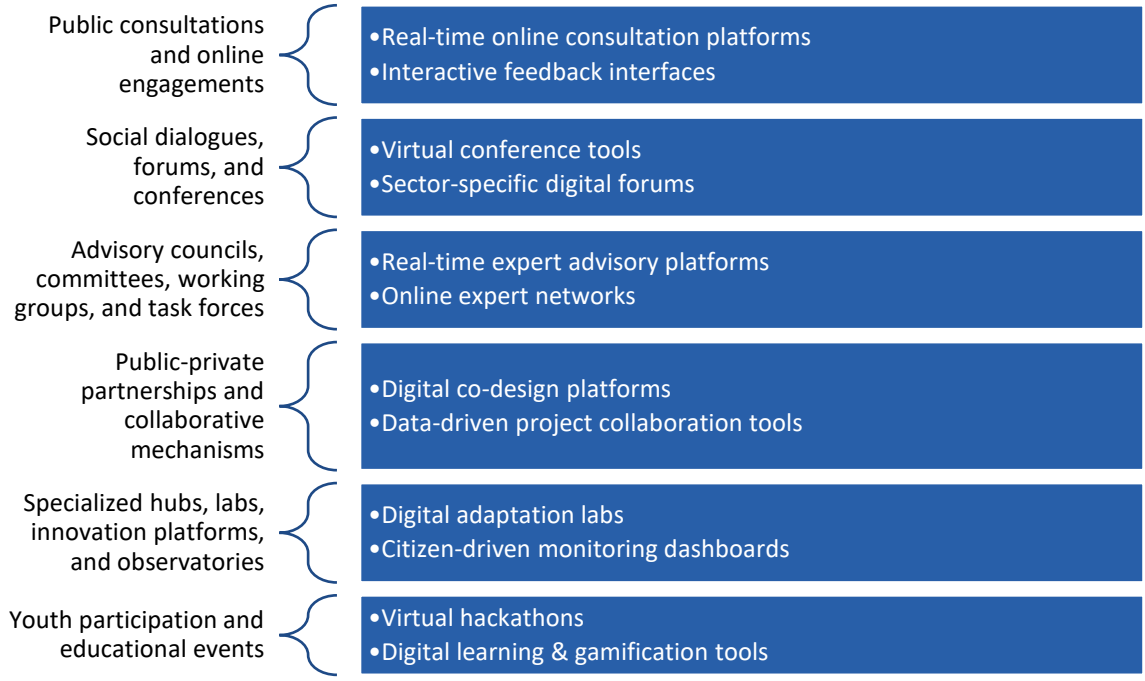

Figure 11: Innovative participatory mechanisms in climate adaptation inspired by digital policy practices

6.3 Nature of participatory mechanisms

Adaptation policies include various participation levels, but digitalization policies offer innovative expansions (see Fig. 12). Mandatory mechanisms such as public hearings exist, but digital policies introduce innovative, **digitally mandated consultation platforms**, enhancing accessibility and participation. Non-binding mechanisms like advisory committees benefit from **digital collaborative networks and voluntary digital codes of conduct**, facilitating broader stakeholder involvement.

Voluntary collaboration mechanisms already exist but are enhanced significantly by digitalization through **crowdsourced digital engagement and innovative peer-to-peer digital learning platforms**.

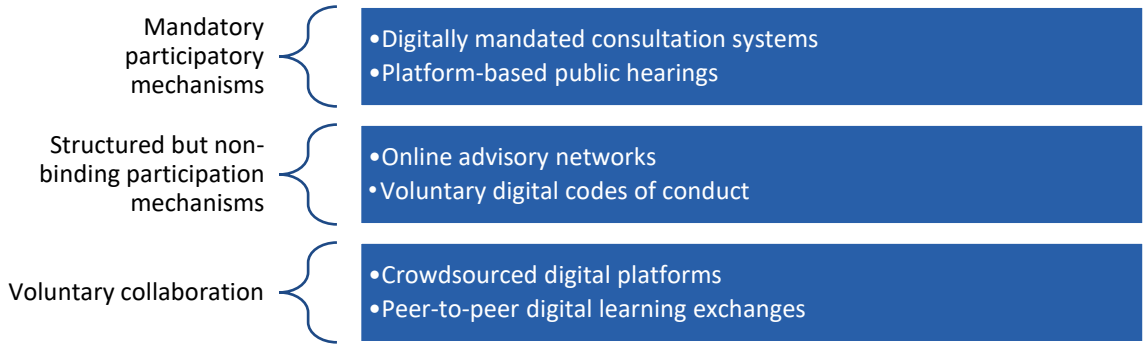

Figure 12: Expanded forms of participation in climate adaptation enabled by digital mechanisms

6.4 Funding sources

Funding transferability highlights innovative digital funding approaches absent or underdeveloped in current adaptation policies (see Fig. 13). Public funding mechanisms like participatory budgeting

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are familiar but can be significantly enhanced through **digital transparency and interactive budgeting platforms**. Private investment, less integrated in current adaptation, benefits greatly from **digital incentives and transparency mechanisms**, attracting greater private sector engagement.

Public-private partnerships are common, but digitalization provides innovative **digital collaboration tools and co-financing mechanisms**, significantly enhancing funding efficiency and stakeholder engagement.

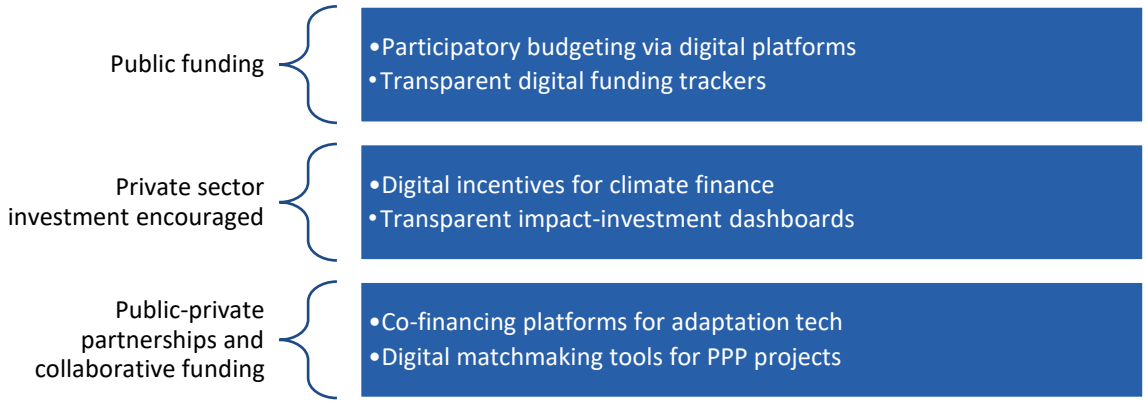

Figure 13: Innovative funding mechanisms for climate adaptation derived from digitalization policies

6.5 Capacity building for participation

Capacity-building measures gain significant innovation from digitalization (see Fig. 14). **Digital literacy training**, not extensively covered in adaptation, represents a substantial innovation allowing stakeholders to engage effectively using digital tools. Public sector training, while present, is innovatively expanded by **digital cross-sector collaboration platforms and digital leadership training**.

Support for SMEs, traditionally limited, benefits significantly from **digital mentorship programs, digital resource hubs, and innovation incubators** specifically targeting climate resilience. **Digital training networks and regional hubs** represent novel digital strategies significantly enhancing stakeholder capacities at scale.

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Figure 14: Digital capacity-building strategies to strengthen participation in climate adaptation

6.6 Measures for transparency and information sharing

Transparency and information sharing are notably enhanced through digital innovations (see Fig. 15). Open data portals exist but digital policies significantly advance these through **interactive climate data platforms and community-driven digital data sharing initiatives**. Transparency tools and repositories become notably innovative through **user-friendly digital archives and digital transparency centres**.

Public reporting, already integral, gains substantial innovation through **interactive digital communication tools and digital reporting platforms**. Sharing best practices innovatively advances through **digital knowledge-sharing forums and best-practice digital libraries**. Ethical frameworks benefit significantly from **transparent digital decision-making processes and stakeholder-driven ethical guidelines development**.

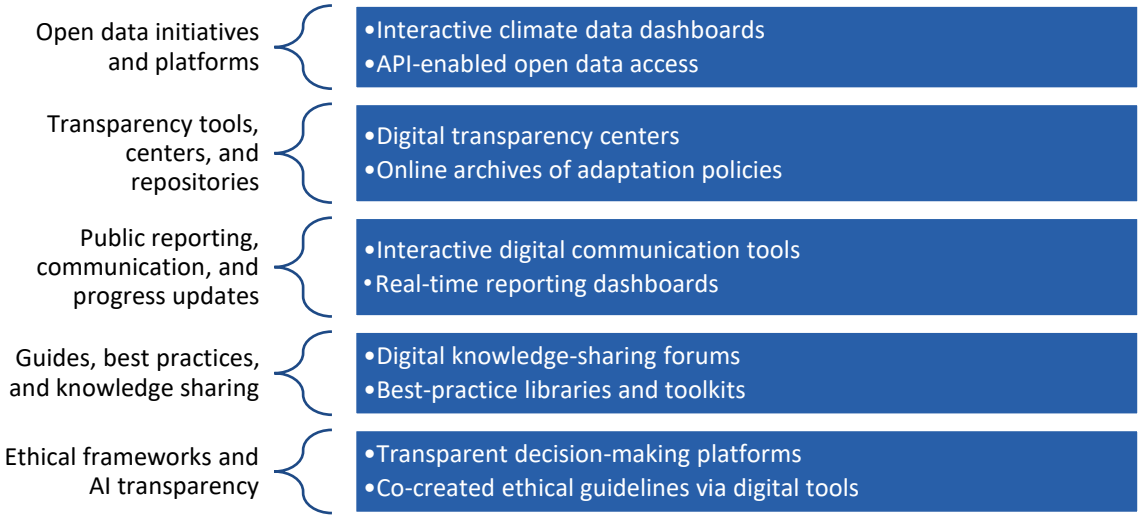

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Figure 15: Digital tools enhancing transparency and information sharing in climate adaptation

6.7 Monitoring and feedback mechanisms

Feedback and monitoring mechanisms are already incorporated but become notably innovative through digitalization (see Fig. 16). Regular stakeholder surveys are innovatively expanded through **real-time digital survey platforms and continuous digital feedback channels**. Monitoring bodies benefit from **innovative digital monitoring platforms and citizen science digital tools**, significantly increasing stakeholder participation.

Evaluation mechanisms, present in adaptation, significantly benefit from **digital adaptive management tools and digitally facilitated stakeholder evaluation workshops**. Transparent reporting innovatively advances through **real-time digital reporting platforms**, increasing accountability and effectiveness of adaptation measures.

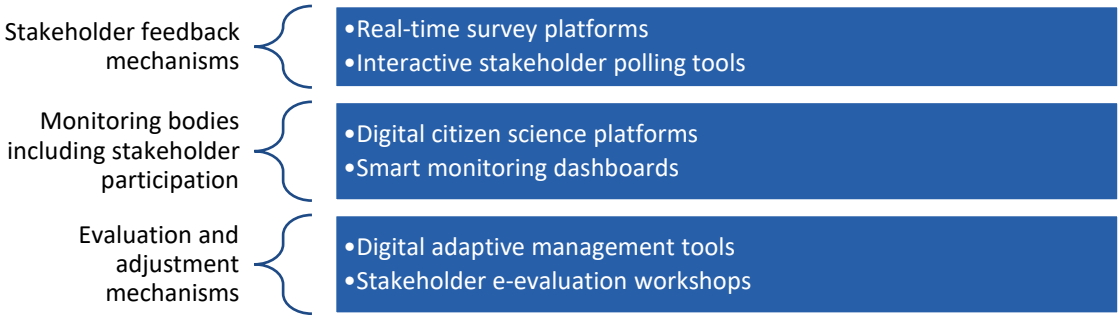

Figure 16: Digitally enabled monitoring and feedback mechanisms in climate adaptation policies

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7. Guidelines for transferability

The guidelines in this section provide actionable strategies for transferring participatory elements from digitalization policies into climate adaptation planning. These steps leverage technological tools and inclusive engagement methods to enhance transparency, innovation, and the overall impact of adaptation efforts. Among these, the most immediately impactful steps are: promoting inclusive design via digital channels (e.g., mobile apps and online forums), providing digital literacy training to overcome participation barriers, establishing open data platforms and clear communication channels for transparency and shared learning, facilitating collaborative online platforms (forums and virtual roundtables) for participatory co-creation, and deploying advanced participation tools (interactive maps, virtual reality) to enable real-time engagement and continuous feedback. These priority actions harness the broad reach and efficiency of digital participation to expand outreach and engagement in adaptation initiatives.

However, these measures must be tailored to local contexts. Given variability in digital infrastructure and resources, practitioners should adapt the recommendations to their specific circumstances, ensuring that chosen tools align with community capacity and needs. By maintaining core principles of inclusivity, transparency, and accountability while adjusting to local capacities, decision-makers can maximize the impact of these digital engagement strategies in diverse climate adaptation settings.

Stakeholder engagement

Effective climate change adaptation hinges on the active involvement of all stakeholders, particularly those most affected by its impacts. Engaging a diverse range of participants ensures that adaptation strategies are comprehensive, equitable, and grounded in real-world needs (see Fig. 17).

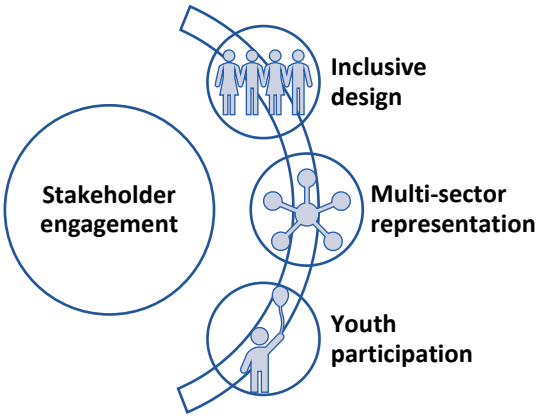

Figure 17: Guidelines overview for stakeholder engagement

- **Inclusive design:** Prioritize the involvement of vulnerable populations and communities directly affected by climate change, addressing the representation gaps concerning marginalized and vulnerable groups. Utilize digital platforms such as mobile applications and

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online forums to ensure accessibility and inclusion of marginalized groups, helping overcome some of the accessibility issues noted in D4.2. By removing geographical and socio-economic barriers, these tools empower all voices to contribute meaningfully to adaptation planning.

- **Multi-sector representation:** Involve diverse stakeholder groups, including citizens, businesses, public authorities, research institutions, and civil society organizations. This holistic approach harnesses a wide array of perspectives and expertise, fostering solutions that are innovative and widely supported and countering the cross-sectoral collaboration gaps highlighted in D4.2.
- **Youth participation:** Establish youth-specific engagement mechanisms, such as ambassador programs, hackathons, or digital innovation labs, explicitly addressing the underrepresentation of youth noted as a gap in D4.2. By tapping into the creativity of younger generations, innovative approaches can be encouraged, and the sustainability of adaptation efforts can be ensured.

Participatory mechanisms

Implementing structured participatory mechanisms is essential for gathering diverse inputs, building consensus, and fostering collaboration among stakeholders (see Fig. 18).

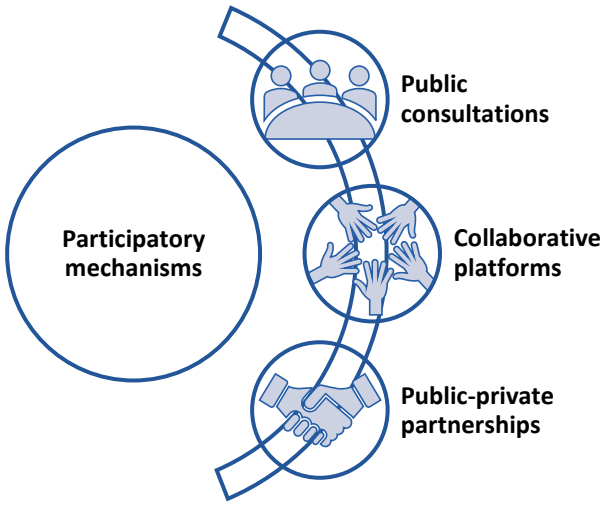

Figure 18: Guidelines overview for participatory mechanisms

- **Public consultations:** Organize online and in-person consultations to gather a wide range of insights and opinions, ensuring broader reach than purely digital or physical methods alone, thus mitigating accessibility barriers identified in D4.2. Digital tools can facilitate broad participation, allowing stakeholders from different regions and backgrounds to contribute to the dialogue.
- **Collaborative platforms:** Facilitate digital forums, roundtables, and advisory committees that enable knowledge exchange and the co-creation of solutions. These platforms promote

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dialogue, partnership, and collective problem-solving, moving beyond the often-tokenistic informing or consultation levels of participation observed in D4.2 towards genuine partnership.

- **Public-private partnerships:** Encourage joint initiatives between governments and private entities to leverage resources, technical expertise, and innovative capacities. Such partnerships can accelerate the implementation of adaptation measures and promote sustainable development, potentially addressing the resource constraints for participation identified in D4.2 and improving SME/business engagement.

Mechanism structuring

The structure of participatory mechanisms influences their effectiveness and the degree to which stakeholders are engaged (see Fig. 19).

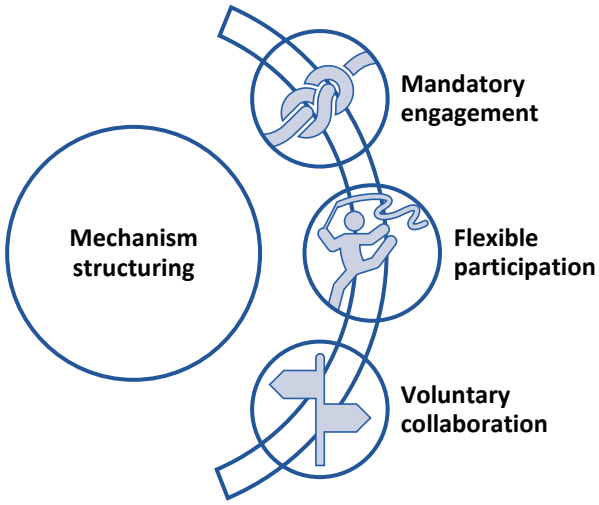

Figure 19: Guidelines overview for mechanism structuring

- **Mandatory engagement:** Embed legal requirements for public consultations and stakeholder involvement in major adaptation projects, tackling the gap related to the often voluntary and non-binding nature of participation found in D4.2. This ensures accountability, transparency, and that diverse voices are considered in decision-making processes.
- **Flexible participation:** Promote structured but non-binding mechanisms, such as advisory councils or working groups, to encourage voluntary yet meaningful contributions. Flexibility can enhance creativity and reduce barriers to participation.
- **Voluntary collaboration:** Support community-led initiatives and crowdsourcing efforts for localized solutions, strengthening the engagement of local and grassroots communities, an area identified as needing improvement in D4.2. Grassroots movements often bring innovative ideas and are crucial for addressing specific local challenges.

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Funding and resources

Securing adequate funding and resources is critical for the success and sustainability of adaptation initiatives (see Fig. 20).

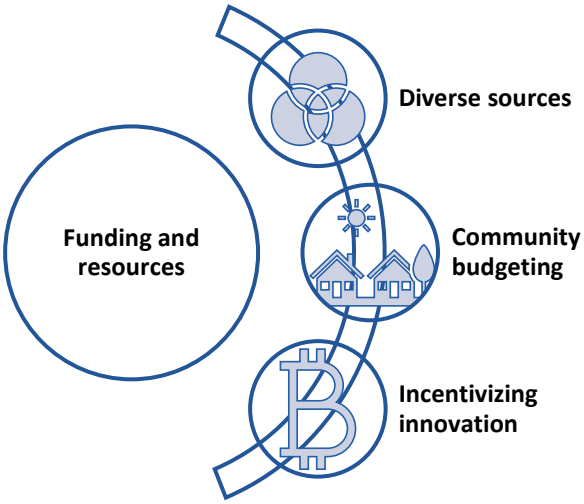

Figure 20: Guidelines overview for funding and resources

- **Diverse sources:** Secure funding through public budgets, private investments, and collaborative models like public-private partnerships, directly addressing the inadequate financial resources often highlighted as a barrier in D4.2. Diversifying funding sources enhances financial stability and reduces dependency on a single source.
- **Community budgeting:** Implement participatory budgeting for local adaptation projects, enabling citizens to influence resource allocation. This approach fosters transparency, accountability, and community ownership of adaptation efforts, helping to bridge the gap between large financial figures and local project needs identified in D4.2.
- **Incentivizing innovation:** Offer financial incentives, such as grants, subsidies, or tax benefits, for businesses investing in adaptation technologies. Encouraging private sector involvement can drive innovation and bring new solutions to scale, thereby also addressing potential gaps in SME engagement noted in D4.2.

Capacity building

Building the capacity of all stakeholders ensures that they can effectively participate in and contribute to adaptation efforts (see Fig. 21).

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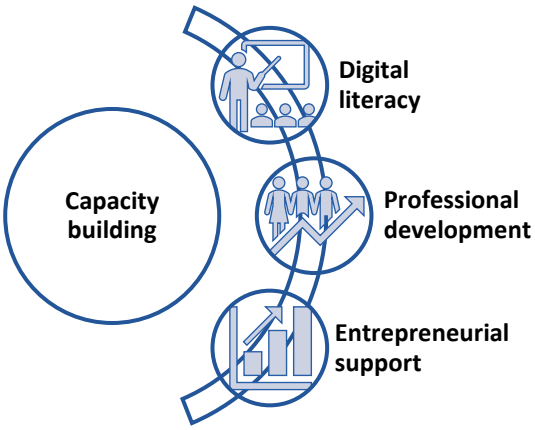

Figure 21: Guidelines overview for capacity building

- **Digital literacy:** Provide training programs to enhance stakeholders' ability to engage with digital tools and participate in climate change adaptation planning, tackling the digital divide component of accessibility gaps identified in D4.2. Improving digital literacy bridges the gap between technology and users, enabling broader participation.
- **Professional development:** Equip public sector employees with the skills needed to lead participatory processes and implement adaptive policies, addressing the limited capacity within governments sometimes noted in D4.2. Continuous learning and development enhance the effectiveness of public services.
- **Entrepreneurial support:** Establish incubators and training centers to support SMEs and start-ups contributing to adaptation innovation. Supporting entrepreneurship stimulates economic growth and fosters the development of new technologies and approaches, , improving engagement with this sector as noted in D4.2.

Transparency and information sharing

Transparency and open information sharing are fundamental for building trust and enabling informed decision-making (see Fig. 22).

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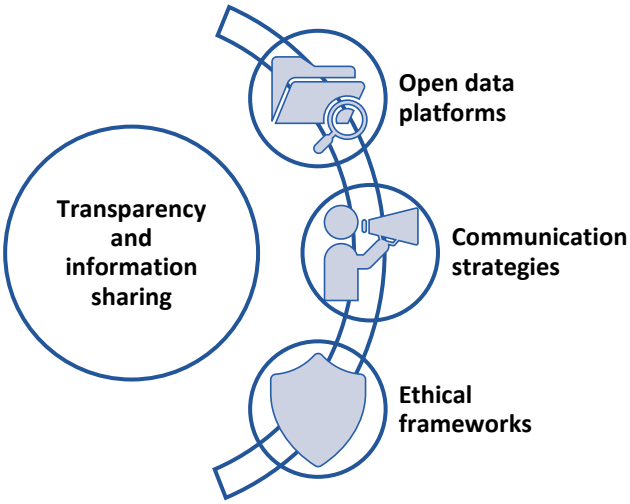

Figure 22: Guidelines overview for transparency and information sharing

- **Open data platforms:** Develop accessible data repositories with climate projections, vulnerability assessments, and adaptation resources, addressing the need for better knowledge accessibility identified as a gap in D4.2. Providing open access to data empowers stakeholders to make informed contributions and facilitates collaborative problem-solving.
- **Communication strategies:** Regularly publish progress reports and use digital media to disseminate success stories, updates, and learning outcomes, responding to D4.2 finding that communication needs simplification and tailoring, and contributing to feedback loops. Effective communication keeps stakeholders informed and engaged throughout the adaptation process.
- **Ethical frameworks:** Ensure data privacy and uphold ethical standards in the use of technological tools. Protecting participant information builds trust and encourages continued engagement.

Monitoring and feedback

Ongoing monitoring and feedback mechanisms are essential for assessing progress and adapting strategies as needed (see Fig. 23).

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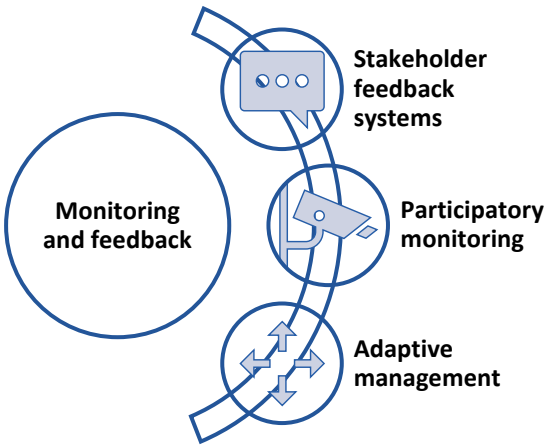

Figure 23: Guidelines overview for monitoring and feedback

- **Stakeholder feedback systems:** Create channels, such as online surveys and comment platforms, to collect continuous input from stakeholders, directly addressing the lack of robust or accessible feedback mechanisms highlighted as a key gap in D4.2. Regular feedback informs improvements and enhances the responsiveness of adaptation initiatives.
- **Participatory monitoring:** Involve communities and multi-stakeholder groups in tracking adaptation progress, fostering sustained engagement beyond initial consultations (a gap noted in D4.2) and increasing accountability. Engaging stakeholders in monitoring increases accountability and ensures that outcomes align with community needs.
- **Adaptive management:** Use monitoring data to refine strategies, address emerging challenges, and capitalize on new opportunities. Adaptive management fosters resilience and the capacity to respond effectively to changing conditions.

Knowledge exchange

Facilitating knowledge exchange accelerates learning and the dissemination of effective practices (see Fig. 24).

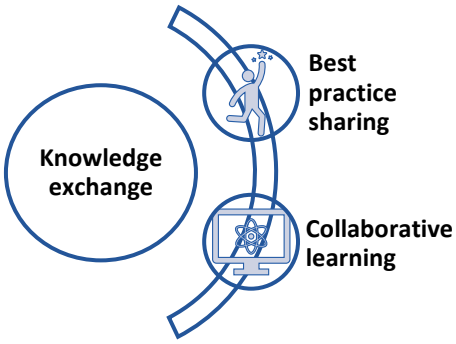

Figure 24: Guidelines overview for knowledge exchange

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- **Best practice sharing:** Develop manuals, case studies, and organize workshops to disseminate proven strategies and methodologies, helping to overcome capacity and knowledge gaps identified in D4.2 by spreading practical insights. Sharing successes and lessons learned promotes wider adoption of effective approaches.
- **Collaborative learning:** Promote peer-to-peer learning through networking events, webinars, and online forums. Collaborative learning environments encourage innovation and strengthen the collective capacity to address complex challenges, particularly fostering the cross-sectoral learning needed to overcome integration gaps noted in D4.2.

Leveraging technology

Technology serves as a powerful tool to enhance participation and the effectiveness of adaptation measures (see Fig. 25).

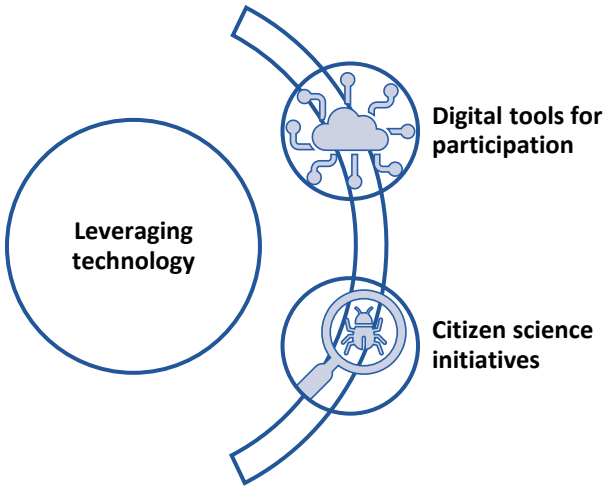

Figure 25: Guidelines overview for leveraging technology

- **Digital tools for participation:** Utilize platforms that enable real-time engagement, enhance accessibility, and visualize adaptation scenarios, directly applying digitalization to address accessibility and engagement depth gaps found in D4.2. Tools such as interactive maps, virtual reality simulations, and mobile apps can make complex information more understandable and engaging.
- **Citizen science initiatives:** Empower communities to contribute local observations and insights through citizen science programs, helping to integrate local and potentially traditional knowledge (addressing a D4.2 gap) and fostering grassroots engagement. Integrating grassroots knowledge enriches data collection and ensures that local contexts are considered in adaptation planning.

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8. Integrating digital collective action and narrative engagement: Case studies for climate adaptation

This section presents two original studies conducted by the IIASA authors of the deliverable and demonstrates how evidence from disaster response and science communication can inform D4.3's guidelines on using digital tools for participatory adaptation. The first study, "Digital collective action and emotional resilience after the 2023 Turkey-Syria earthquake: Insights from Facebook engagement" (unpublished, forthcoming), is a case study of social media use following the earthquake. The second study, "Understanding narrative preferences for climate change engagement among scientific experts" (unpublished, forthcoming), is a survey of climate and adaptation experts on storytelling strategies. The findings of these studies provide concrete examples and empirical support to strengthen the report's recommendations on digital engagement strategies.

8.1 Digital collective action and emotional resilience

In "Digital collective action and emotional resilience after the 2023 Turkey-Syria earthquake: Insights from Facebook engagement", the authors conducted a mixed-method analysis of Facebook activity during the three months following the February 2023 earthquake. The dataset comprised over 30 000 posts and 150 000 comments from eight large public Facebook groups focused on relief and solidarity. Methods included automated sentiment analysis to track emotional tone, thematic content coding to identify post topics (such as requests for aid or personal updates), and social network analysis to map user interactions. This approach captured how residents and volunteers used social media to respond to the disaster.

Key findings from the Facebook case study include:

- **Rapid mobilization and information sharing:** Community members used Facebook groups to coordinate relief efforts in real time. Over 70% of early posts contained actionable information (such as calls for volunteers, donation drives, or missing persons reports). These posts received substantially higher engagement (hundreds of likes, shares, and comments) than non-action posts, indicating effective digital mobilization. Within days, dozens of volunteer teams and fundraising initiatives had been organized through these platforms.
- **Emotional support and resilience:** Sentiment analysis showed an initial surge of fear and sadness immediately after the earthquake, which gradually shifted toward hope and solidarity. By the third week, posts expressing encouragement, gratitude, or communal strength outnumbered negative posts. Qualitative coding found that many users shared personal survival stories or offered words of support. For example, a widely shared post

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depicting a reunited family prompted hundreds of supportive comments. These patterns indicate that online communities provided psychosocial support and built collective resilience over time.

- **Community network formation:** Social network analysis revealed the emergence of new online clusters centered on specific relief tasks. Certain highly active users (often local volunteers or NGOs) became hubs connecting disparate groups. Sub-communities formed to address logistics (e.g., supply distribution, medical aid) and fundraising, often bridging geographic boundaries. Notably, diaspora members and international supporters joined local groups, broadening the support network. These bridges meant resources and information circulated widely beyond traditional localities.

Together, these findings demonstrate that social media can be a powerful instrument for collective action and community coping during crises. The case study shows how a digital platform facilitated both practical coordination and emotional support in a disaster context. For climate adaptation, these insights imply that similar online infrastructures can be leveraged to engage citizens and build resilience. For example, adaptation programs could create digital hubs where community members share local adaptation knowledge and solutions, coordinate grassroots initiatives (such as neighborhood flood defenses or water-saving campaigns), and encourage one another during extreme events. These insights support D4.3's guidelines by illustrating how participatory digital tools can mobilize community-driven adaptation actions and reinforce social bonds.

8.2 Understanding narrative preferences for climate change engagement

The second study, "Understanding narrative preferences for climate change engagement among scientific experts", used a structured survey to gather insights from climate scientists, adaptation researchers, and practitioners (approximately 120 respondents). Participants evaluated different climate-change message formats and storytelling frames. The survey presented hypothetical narrative examples such as heroic success stories (e.g., a community overcoming flood risks), local impact vignettes (e.g., a family adapting to drought), future vision scenarios (long-term climate projections with adaptation pathways), and urgent crisis narratives. Respondents rated each narrative on perceived effectiveness for engaging diverse audiences and motivating action.

This survey yielded several key insights:

- **Preference for solution- and resilience-oriented narratives:** A large majority of experts favored positive, empowerment-focused stories. For example, 85% of respondents rated a "community triumph" adaptation story as very effective, whereas 70% found an apocalyptic "climate collapse" narrative ineffective. Many comments emphasized that hopeful, actionable narratives are more likely to inspire participation, while fear-based messages tend to induce helplessness or disengagement. This suggests that adaptation

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communications should highlight successful adaptation efforts and human agency rather than focusing solely on catastrophes.

- **Importance of local and relatable context:** Many participants stressed that narratives rooted in familiar settings resonate more strongly than abstract or distant accounts. Experts noted that describing specific places, people, and challenges makes stories tangible and relevant. Incorporating local cultural details (such as landmarks, occupations, or vernacular language) was seen as enhancing audience connection. For example, featuring a local farmer or city official adapting to climate impacts was considered far more engaging than a generic global description. These preferences align with digital adaptation approaches that tailor content to community context.
- **Integration of data and story:** Respondents generally agreed that combining solid data with storytelling enhances credibility and understanding. A common suggestion was to embed visual evidence (such as charts, maps or infographics) within a narrative context. They cautioned, however, that presenting raw technical information without an accompanying story can lose the audience. For instance, experts praised a narrative that included a simple flood-risk chart alongside a community's adaptation plan, whereas they critiqued uncontextualized statistics as dry. This indicates that adaptation guidelines should advocate using data to support and enrich stories, not overwhelm them.
- **Multimedia and interactive formats:** The survey also revealed strong format preferences. Short video clips, animations, and interactive graphics were consistently rated as more engaging than lengthy text. Many experts recommended using multimedia storytelling to capture public interest. For example, an animated video of adaptation success or an interactive timeline of community actions was highlighted as effective. This suggests that digital adaptation tools should prioritize rich media (videos, slideshows, interactive maps) to convey both narrative and data.

These survey findings have direct implications for participatory adaptation guidelines. They suggest that digital engagement tools should incorporate the narrative elements experts find most compelling: solution-oriented, context-specific, and data-supported stories, delivered through rich media. For example, an online adaptation platform might include a "Local success stories" section where users explore real case studies via videos, testimonials, and infographics. Features could allow practitioners and citizens to upload their own adaptation anecdotes using pre-designed prompts. By aligning communications with these preferences, practitioners can make their digital outreach more effective and trustworthy.

Taken together, the two studies underscore several principles for using digital tools in participatory climate adaptation and can be translated into actionable recommendations:

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- **Leverage social platforms for co-creation:** Establish online groups or forums where citizens and experts co-design local adaptation solutions. Use collaborative idea boards and live discussions, emulating volunteer coordination.
- **Foster positive engagement:** Actively share success stories, milestones, and positive feedback in digital campaigns to build community morale. Training community leaders to narrate uplifting adaptation experiences on social media can maintain momentum, reflecting the supportive environment observed among earthquake survivors.
- **Use tailored narratives in digital tools:** Incorporate storytelling prompts and templates based on expert preferences. For example, a flood-awareness app could include a section where users read or submit short stories of neighbors successfully adapting to floods, emphasizing hope and local context as recommended by the survey findings.
- **Combine data with storytelling:** Design websites or apps that present climate risks with local data visualizations alongside personal testimonials. Practitioners might use interactive story maps that layer scientific forecasts with real-life adaptation case studies, following the study advice to integrate data and human narratives.
- **Offer multimedia engagement:** Provide videos, animations, and interactive content to appeal to diverse audiences. For instance, share short documentary-style clips of community adaptation projects or create interactive quizzes about climate actions. Encouraging users to contribute their own photos or videos of adaptation efforts can further increase relevance and ownership.

Grounding these recommendations in empirical evidence makes adaptation programs more participatory and resilient. The intersection of analytical rigor and human-centered storytelling as demonstrated by these case studies should guide the design of digital engagement tools. In this way, transferring digital engagement practices from disaster response and communication research into climate adaptation can build stronger, more resilient communities.

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9. Conclusion

This report underscores the transformative potential of leveraging participatory elements from digitalization policies to enhance climate change adaptation initiatives. Through an examination of successful mechanisms in the digital realm such as stakeholder engagement strategies, public-private partnerships, and capacity-building programs the analysis identifies clear pathways for fostering inclusive, transparent, and innovative adaptation processes. As Adaptation AGORA's Deliverable D2.1 notes, developing participatory tools and approaches for co-designing equitable, context-sensitive adaptation strategies is essential for effective local adaptation planning.

The findings highlight the critical role of diverse stakeholder groups including vulnerable populations, businesses, and educational institutions in co-creating adaptive solutions that are both equitable and effective. In line with this, Deliverable D2.1 emphasizes engaging diverse communities (including marginalized groups) and promoting equity and climate justice in the co-design of adaptation measures. Moreover, the spectrum of participatory mechanisms outlined (ranging from public consultations to collaborative innovation platforms) demonstrates how a blend of structured and flexible approaches can drive meaningful engagement in adaptation efforts. Similarly, Deliverable D5.1 reports that co-production workshops in the pilot regions created highly participatory environments by leveraging local knowledge and focusing on community vulnerabilities, thereby generating tailored adaptation solutions.

The proposed guidelines offer actionable steps for integrating these participatory elements into climate change adaptation efforts, with an emphasis on aligning each approach with local contexts and challenges. As highlighted in D2.1, adaptation actions should align with each community's specific vulnerabilities and priorities. However, it is also crucial to acknowledge that not all digital instruments will be feasible or appropriate in every local adaptation context. Resource constraints, limited digital infrastructure, or other contextual factors may limit the applicability of certain tools. For example, Deliverable D5.1 emphasizes that capacity-building resources were tailored to address each pilot's unique climate risks and needs, thereby empowering local participants and reinforcing resilience. Practitioners are therefore encouraged to adapt these recommendations to their specific circumstances, maintaining the core principles of inclusivity, transparency, and accountability. By allowing such flexibility, the guidelines aim to build resilient communities equipped to tackle the multifaceted impacts of climate change.

By bridging the gap between digitalization and climate change adaptation policies, this report directly supports Adaptation AGORA's broader mission of fostering societal resilience and sustainability. As D5.1 highlights, co-production and capacity-building initiatives can significantly empower citizens, promoting bottom-up, community-driven climate engagement. Deliverable D2.1 likewise emphasizes that co-designed adaptation measures advance climate justice and equity, strengthening community resilience. If pursued, integrating these innovative participatory

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instruments into climate adaptation policies will mark a significant step toward transformative, community-driven climate resilience, ultimately reaffirming this deliverable's contribution to Adaptation AGORA's mission to empower communities and advance effective, inclusive climate action.

The analysis of other policy areas can further inform and enrich participation in climate change adaptation policies. For instance, IIASA colleagues have conducted comparative research on participatory elements within European water management policies (unpublished, forthcoming), highlighting diverse instruments and practices that successfully engage citizens. Specific examples include Denmark's approach of citizen participation in flood-risk mapping and water monitoring, Estonia's use of information-based tools for risk-area mapping and infrastructure upgrades, and Austria's emphasis on information-based instruments such as analyzing existing data, promoting responsible water use, and enhancing coordination on water demand. Such cross-sectoral exchange of participatory insights can significantly enhance stakeholder engagement, promoting broader and deeper participation across climate adaptation efforts, and ultimately strengthen societal resilience in various sectors.

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