

EREM 82/3Journal of Environmental Research,
Engineering and Management

Vol. 82 / No. 3 / 2026

pp. 6–20

10.5755/j01.erem.82.3.44287

Analysis of Barriers within the Decision-making Chain for German and Danish SMEs Supplying Climate Adaptation Solutions

Received 2026/02

Accepted after revisions 2026/08

<https://doi.org/10.5755/j01.erem.82.3.44287>

Analysis of Barriers within the Decision-making Chain for German and Danish SMEs Supplying Climate Adaptation Solutions

Rikke Lybæk^{1*}, Agnes Sachse², Sebastian H. Mernild³¹ Department of People and Technology, Roskilde University (RUC), Denmark² Institute of Geosciences, Christian-Albrechts-University zu Kiel (CAU), Germany³ SDU Climate Cluster, University of Southern Denmark (SDU), Denmark***Corresponding author:** rbl@ruc.dk

Climate adaptation has become a central policy priority across Europe, yet the uptake of new adaptation solutions remains slow, particularly within public-sector markets. Small and medium-sized enterprises play an important role in developing innovative climate adaptation technologies, but often struggle to gain access to planning, procurement and implementation processes shaped by established routines, regulatory complexity and risk aversion. This paper analyses the barriers faced by SMEs supplying climate adaptation solutions in Denmark and Northern Germany. Based on semi-structured interviews with ten SMEs offering a wide range of nature-based, digital and mobile adaptation solutions, the study examines how companies encounter the public-sector decision-making chain from risk assessment and planning to procurement and implementation. The analysis is informed by diffusion of innovation theory, combined with insights from research on public-sector innovation barriers. The findings suggest that barriers to diffusion are unevenly distributed along the decision-making chain, with the planning stage emerging as the most critical bottleneck. Exclusion from early planning reinforces path dependency and limits the consideration of alternative solutions, even when these display clear advantages. Later stages are further constrained by limited observability, restricted trialability, compatibility issues and weak knowledge transfer during implementation. Overall, the study indicates that adoption barriers are primarily institutional rather than technological, highlighting the importance of early engagement, trust and organisational capacity for accelerating climate adaptation in public-sector contexts.

Keywords: Barriers, climate adaptation, Denmark, Germany, small and medium-sized enterprises.

Introduction

Climate change is already producing tangible impacts across Europe, but the consequences are also pronounced in Northern Europe including Denmark and Northern Germany (IPCC, 2021). Recent regional climate assessments document rising mean temperatures, increasing annual precipitation and a growing frequency of extreme rainfall events. Projections indicate that precipitation in this region may increase by 5–15% by the end of the century, while extreme precipitation days become more frequent, intensifying risks related to pluvial flooding, groundwater rise and coastal inundation (Mernild, 2025). At the same time, sea level rise along the North Sea and western Baltic Sea coasts is accelerating. Projections suggest relative sea level increases of up to 0.8 metres by year 2100 under high-emission scenarios, implying that flooding events currently considered rare may occur far more frequently in the future. Together, these developments point to a growing and urgent need for effective climate adaptation measures at the municipal and regional levels, particularly in low-lying and coastal areas (Mernild, 2025).

In response, climate adaptation has become an evolving policy priority across Europe, reflecting the growing imperative to strengthen resilience as climate impacts intensify (EC, 2021; Pietrapertosa, 2023; Tahereh and Nadejda, 2025;). The European Union first addressed climate adaptation formally through the EU Adaptation Strategy adopted in 2013, which aimed to improve preparedness, support member state action and mainstream adaptation across EU sectoral policies and funding instruments (EC, 2013; Pietrapertosa, 2023). Building on this foundation, the strategy was revised in 2021 under the European Green Deal with the adoption of the new EU Adaptation Strategy, *'Forging a climate-resilient Europe'*, which sets the objective of achieving climate resilience by 2050 (EC, 2021). The revised strategy emphasizes smarter, faster and more systemic adaptation, strengthening climate risk knowledge, accelerating implementation, and integrating adaptation across governance levels and policy sectors (EC, 2021; EEA, 2025). Adaptation has also been reinforced through the 'European Climate Law', which establishes a legal obligation for the EU and its Member States to enhance adaptive capacity,

strengthen resilience, and reduce vulnerability to climate change (EU, 2021). As a result, all EU Member States have now adopted national adaptation policies, with increasing alignment between adaptation strategies, national climate laws, and sectoral planning (EEA, 2025). This evolving policy framework reflects a shift from strategic planning toward implementation and risk management, aiming to address growing climate risks such as heatwaves, floods, droughts and ecosystem degradation across Europe.

However, despite increasing political attention and the availability of various technical solutions (Seidu et al., 2025; Ayadi et al., 2025), implementation remains slow and uneven within Europe (Colocci et al., 2025; de Bruyn et al., 2026). In many regions, adaptation efforts lag behind identified risks, creating a widening gap between policy ambitions and on-the-ground action (Buga and Yousif, 2021; Ye et al., 2026). This gap is therefore not caused by a lack of adaptation solutions, but by challenges related to governance, decision-making processes and institutional capacity. Recent assessments from the North Sea Region, including results from the research project 'POSEIDON', thus underline these challenges in the Danish-German programme region. While the need for adaptation is well documented (Trautmann and Siegmund, 2021; Larsen et al, 2021; Colgan et al., 2022; Mernild, 2025) the translation of risk knowledge into concrete measures is often hindered by organisational fragmentation, complex administrative procedures, uncertainty about responsibilities and lack of participation (Lange et al., 2021; Colocci et al., 2025). Accelerating climate adaptation therefore requires not only new technologies, but also governance arrangements that enable innovative solutions to be considered, evaluated and implemented in practice (Lybæk and Grindsted, 2025; Rimlinger et al., 2026), including a move beyond classic silo thinking (Mehvar et al., 2025). Overall, the literature highlights that climate adaptation barriers are widely acknowledged. Although previous research increasingly recognises that adaptation processes unfold across multiple stages, barriers are often examined as relatively separate governance or innovation-related factors rather than in relation to their positioning within a structured decision-making process. At the same time, limited attention has been paid to SMEs as providers of climate adaptation solutions and to how institutional decision-making processes shape their access to public-sector markets. While previous

studies have identified a wide range of governance, organisational and innovation-related barriers to climate adaptation (Moser and Ekstrom, 2010; Biesbroek et al., 2013; Eisenack et al., 2014), less attention has been given to how these barriers emerge and interact across the different stages of the public-sector decision-making chain. Consequently, there is still limited understanding of how institutional dynamics influence the uptake of innovative climate adaptation solutions from SMEs in practice. To address this gap, this study aims to analyse how and where SMEs supplying climate adaptation solutions encounter barriers when entering public-sector markets in Denmark and Northern Germany. The study focuses specifically on the stages from risk assessment to implementation. Accordingly, the study addresses the following research question:

How and where do SMEs supplying climate adaptation solutions encounter barriers across the public-sector decision-making chain in Denmark and Northern Germany?

To address this research question, the paper examines how factors such as visibility, trust, compatibility with existing systems and administrative requirements shape SME access to public-sector markets. Particular attention is given to the planning stage and the importance of early engagement, as timing and relationships often determine whether innovative solutions are considered at all. As noted above, earlier research has identified a wide range of governance, organisational and innovation-related barriers to climate adaptation (Moser and Ekstrom, 2010; Biesbroek et al., 2013; Eisenack et al., 2014), but these barriers are often analysed as isolated factors operating independently of one another. Although adaptation research increasingly recognises that adaptation processes unfold through multiple stages and involve interactions between actors, institutions and governance arrangements over time (Moser and Ekstrom, 2010; Wise et al., 2014), less attention has been paid to how barriers emerge across different stages of the public-sector decision-making chain and become more or less influential.

This study therefore builds on existing research by examining how adaptation barriers become more or less influential across different stages of the public-sector decision-making chain. This allows analysis of how particular barriers become more or less influential at different stages of risk assessment, planning,

procurement and implementation. In doing so, the paper highlights the importance of examining barriers in relation to their stage-specific and institutional positioning within public-sector decision-making processes.

This paper thus contributes to the literature on climate adaptation governance and innovation diffusion in three ways. First, it illustrates how adoption barriers are unevenly distributed along the public-sector decision-making chain, with the planning stage emerging as a critical bottleneck for SME-driven climate adaptation solutions. Second, by adopting a supplier perspective, it provides new insights into how institutional factors, including risk aversion, reliance on external advisors and planning routines, may constrain market access for innovative SMEs. Third, by drawing on cases from both Denmark and Northern Germany, the study examines whether similar barriers to diffusion emerge across different institutional settings. Rather than seeking a systematic comparison between national governance systems, the analysis explores the extent to which common institutional mechanisms shape SME access to climate adaptation markets across the two contexts.

More broadly, the findings suggest that barriers to climate adaptation may be understood as stage-specific mechanisms embedded within institutional decision-making processes. Rather than being evenly distributed along the decision-making chain, barriers vary in importance across stages and shape opportunities for innovation uptake in different ways. Taken together, the findings contribute to climate adaptation and innovation diffusion research by showing how and where adoption barriers are structured along the public-sector decision-making chain, with special emphasis on the planning stage, which is identified as the primary bottleneck. The following section outlines the methodological approach and theoretical framework applied in the study.

Methods

This section elaborates on the theoretical framework adopted in this paper and how interviews and coding of data are handled, and which companies are chosen for the case study of German and Danish SMEs seeking to enter the public market with climate adaptation solutions.

Theoretical framework

This study examines how SMEs supplying climate adaptation solutions encounter barriers across the public-sector decision-making chain. Climate adaptation solutions are rarely adopted through a single decision. Instead, the adoption process unfolds through a sequence of interrelated stages involving risk assessment, planning, procurement and implementation. While previous research has identified a wide range of governance, organisational and innovation-related barriers to climate adaptation (Moser and Ekstrom, 2010; Biesbroek et al., 2013; Eisenack et al., 2014) – and increasingly recognises that adaptation processes unfold through interactions among actors, institutions and governance arrangements across multiple stages (Wise et al., 2014) – less attention has been paid to how barriers emerge and interact across different stages of public-sector decision-making processes. To analyse how barriers arise and influence the uptake of climate adaptation solutions across these stages, the study combines diffusion of innovation theory with insights from climate adaptation research and public-sector innovation literature.

To analyse these processes, the study draws on Rogers' Diffusion of Innovations theory (2003). Rogers conceptualises innovation adoption as a process through which innovations are evaluated and either adopted or rejected over time. According to the theory, adoption is influenced by five key innovation attributes: relative advantage, compatibility, complexity, trialability and observability. Relative advantage refers to the extent to which an innovation is perceived as superior to existing alternatives, while compatibility concerns its fit with existing values, routines and organisational practices. Complexity relates to the perceived difficulty of understanding and applying an innovation. Trialability and observability refer to opportunities for testing innovations and observing their results in practice. These attributes provide a useful framework for understanding why some climate adaptation solutions are adopted more readily than others.

Diffusion of innovation theory is particularly relevant to this study because it emphasises how communication processes, organisational routines and decision-making structures influence the uptake of new solutions. Compared to more technology-centred adoption models, the diffusion perspective enables analysis of how

SMEs encounter barriers as they seek to introduce climate adaptation solutions into public-sector contexts. Particular emphasis is placed on institutional routines, communication processes and the sequencing of decision-making stages. However, Rogers' framework was originally developed to explain innovation adoption among individuals and organisations rather than within complex public-sector governance systems. Consequently, the theory does not fully account for factors such as administrative path dependency, formal planning procedures, organisational fragmentation, public accountability requirements and institutional risk aversion.

To address these limitations, the present study combines diffusion theory with insights from climate adaptation barrier research and public-sector innovation literature. Climate adaptation studies have demonstrated that barriers emerge throughout adaptation processes and across multiple organisational and institutional contexts (Moser and Ekstrom, 2010; Biesbroek et al., 2013; Eisenack et al., 2014). Research on public-sector innovation and procurement has further shown how administrative procedures, planning routines, tendering structures, organisational risk aversion and formal decision-making requirements may unintentionally disadvantage innovative suppliers, particularly SMEs with limited resources and market visibility (Edler and Georghiou, 2007; Uyarra et al., 2014; Edquist and Zabala-Iturriagoitia, 2012). Previous studies have also highlighted how institutional arrangements, including procurement practices and procurement instruments, influence opportunities for innovation adoption and supplier participation within public-sector markets (Georghiou et al., 2014).

From this perspective, barriers to innovation adoption should not be understood as isolated obstacles or as confined to a single administrative stage. Rather, they are embedded within broader institutional environments that shape how solutions are recognised, evaluated and implemented throughout public-sector decision-making processes. Rogers' (2003) innovation attributes are therefore not applied as standalone explanatory variables, but as analytical lenses through which diffusion processes embedded within institutional contexts can be examined.

The analytical framework consequently combines the public-sector decision-making chain (risk assessment

→ planning → procurement → implementation) with diffusion-related and institutional barriers. While diffusion theory provides concepts for understanding how innovation characteristics influence adoption, climate adaptation research and public-sector innovation and procurement research help explain how governance arrangements, organisational routines, planning practices and procurement structures shape opportunities for adoption. Together, these perspectives provide complementary analytical lenses for examining how barriers emerge, interact and become more or less influential across different stages of the decision-making chain. The framework was used to guide both the interviews and the subsequent analysis. It was also used to examine how SMEs experience visibility constraints, limited early engagement, risk aversion, compatibility challenges, administrative complexity, observability constraints, trialability limitations and knowledge transfer barriers when attempting to introduce climate adaptation solutions into public-sector markets in Denmark and Northern Germany.

Based on the theoretical framework, the study identifies a number of diffusion-related and institutional barriers that may influence SME access to public-sector climate adaptation markets. The following section outlines the main barrier categories explored in the interviews and applied in the subsequent analysis.

Company barriers

When SMEs try to introduce new climate adaptation technologies into the markets, they can meet several types of challenges, which are exemplified in the following.

One challenge is to demonstrate that their technology clearly offers something better than what is already available (relative advantage). Even if it does, customers - including public authorities - might hesitate if the solution does not fit well with their existing systems, strategies or ways of working (compatibility). If the

solution appears complicated or difficult to understand, this can also discourage adoption (complexity). Another important factor concerns opportunities to test adaptation solutions on a small scale before wider deployment. Potential adopters often prefer to observe solutions operating in practice before committing to full-scale implementation (trialability). The ability to demonstrate the performance and benefits of a technology in practice (observability) is equally important, as observable success stories often encourage others to adopt.

Besides the adaptation solution itself, companies may also face other barriers, such as high costs or uncertainty about the economic benefits, which can make customers cautious (economic barriers). Strict rules for procurement and administration can also make it difficult for smaller companies to even enter the competition (regulatory and administrative barriers). Public organizations can often be conservative and prefer familiar, well-known climate adaptation solutions - and possibly also certain established companies - because they want to avoid risk (risk aversion). Finally, many small companies struggle simply to make themselves known to the right decision-makers or to build the trust needed to be considered for projects dealing with climate change (communication, trust and visibility barriers). The decision-making chain (risk assessment → planning → procurement → implementation) is presented below in *Fig. 1*.

The figure illustrates the four-stage public-sector decision-making chain and highlights how key barriers to diffusion emerge across these stages. The figure provides a simplified overview of the analytical findings, showing how different types of barriers are associated with different stages of the process. In particular, the planning stage is identified as a critical bottleneck, where early engagement and institutional factors such as risk aversion significantly influence the uptake of innovative climate adaptation solutions.

Fig. 1. The public-sector decision-making chain and examples of key barriers to diffusion

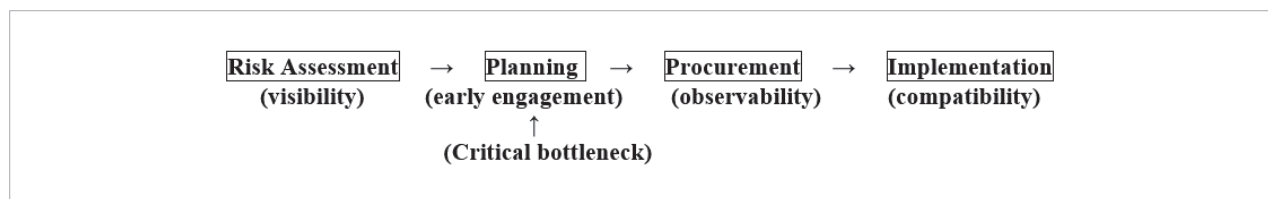


Fig. 1 offers a simple visual representation of the overall process and highlights the planning stage as a critical bottleneck, while Table 1 below provides a more detailed analytical framework, linking stages in the decision-making chain with different types of barriers and interview focus. The categories presented are theory-informed analytical lenses derived from diffusion of innovation theory and public-sector innovation literature and refined through inductive analysis of interview data.

The different barrier categories, identified in Table 1, are analytically related but not identical. Diffusion-related barriers such as observability, trialability and compatibility refer primarily to characteristics influencing the uptake of innovations, whereas administrative and regulatory barriers relate to formal procedures and requirements governing public-sector decision-making. Broader institutional barriers are understood as the decision-making routines and governance arrangements

that shape when and how climate adaptation solutions are considered throughout the decision-making chain. Below, we proceed to detail the interview methods and the choice of case companies interviewed in the following section.

Interview methods

This investigation relies on semi-structured interviews (Kvale and Brinkmann, 2015) to collect qualitative data from key stakeholders in Denmark and Northern Germany. Semi-structured interviews are particularly suited for this research because they allow for in-depth exploration of the complex decision-making processes (Yin, 2018) associated with climate adaptation projects. The method ensures that core themes related to barriers to diffusion are consistently covered across all interviews, while also allowing flexibility to follow up on new insights as they arise. Interviews were guided by the theoretical framework developed from Rogers'

Table 1. Combining the decision-making chain with diffusion of innovation theory and interview focus

Stages in the decision-making chain	Interview focus	Type of barriers
Risk assessment	- How difficult it is for companies to gain visibility and communicate the value of their solutions to the right public actors. - Focus is on getting noticed, building trust and entering the market, and - Often require strong personal networks.	- Communication - Visibility barriers - Trust
Planning	- How well the technology fits with existing municipal systems, routines and planning logics. - Can companies be involved early enough to influence decisions. - Whether public actors are willing and able to think in integrated, cross-sectoral ways.	- Compatibility barriers - Regulatory and administrative barriers - Economic barriers - Risk aversion - Lack of early engagement
Procurement	- How companies handle complex and resource-intensive tender procedures, and how municipalities evaluate and select technologies. - Public actors often rely on advisors, avoid unfamiliar solutions, or favour the cheapest option; even if better alternatives exist.	- Regulatory and administrative barriers - Complexity - Risk aversion - Trialability - Observability
Implementation	- How the adaptation solutions are handled once they are installed or deployed in real-world contexts. - Barriers include lack of technical knowledge, insufficient training, weak coordination between departments. - Unclear responsibility for maintenance and operation.	- Compatibility barriers - Regulatory and administrative barriers

*Table by authors based on Rogers (2003); Edler and Georghiou (2007); Uyarra et al., (2014).

(2003) diffusion theory and later studies on public-sector innovation barriers (see Edler and Georghiou, 2007; Uyarra et al., 2014), covering the entire decision-making chain. The interviews emphasise identifying at which stages of the decision-making process small companies encounter barriers. They also examine how factors such as public procurement rules, risk aversion and organizational routines affect their chances of entering the market with new climate adaptation technologies.

All interviews have been transcribed and analysed using a thematic coding approach (Braun and Clarke, 2006). An initial coding framework was developed based on the theoretical concepts derived from diffusion of innovation theory and the literature on public-sector innovation barriers, including early engagement, risk aversion, observability, compatibility and administrative complexity. During the coding process, this framework was iteratively refined to incorporate empirically grounded themes emerging from the interviews (Saldaña, 2016). Coding was conducted across the full decision-making chain, enabling identification of how barriers manifest at different stages and across the two institutional contexts.

Initial codes were derived from the theoretical framework and included categories such as relative advantage, compatibility, observability, trialability, risk aversion and administrative complexity. During analysis, additional inductive codes emerged from the empirical material, including advisor dependence, visibility constraints, delayed involvement and knowledge transfer challenges. Interview segments could receive multiple codes where several barriers were found to interact simultaneously. Analytical consistency was maintained through continuous comparison across interviews and across national contexts, enabling identification of recurring patterns as well as divergent experiences among the participating SMEs. As the coding was conducted by the first author, intercoder validation was not applied. Instead, analytical consistency was ensured through iterative comparison across cases and coding rounds.

The categories, presented in *Table 1* above, should therefore be understood as theory-informed analytical lenses rather than fixed empirical classifications. While the initial coding framework was derived from diffusion of innovation theory and public-sector innovation

literature, the analysis also incorporated additional themes emerging inductively from the interview material.

Data saturation was considered reached when no substantially new themes emerged across the final interviews, particularly in relation to the key stages of the decision-making chain. To enhance validity and reliability, the coding framework was consistently applied across all interviews, with continuous comparison between cases to ensure analytical consistency.

Choice of case companies and relevance

Across both Germany and Denmark, the selected cases are analytically comparable in that they all engage with public-sector decision-making chains, face similar forms of risk aversion and administrative complexity, and depend on early engagement, trust-building and demonstrable performance to gain market access. This shared context provides a coherent basis for examining whether similar barriers to diffusion emerge across two institutional contexts, while still allowing sensitivity to institutional and regulatory differences between the two countries. The selection of the ten SMEs follows a purposive sampling strategy aimed at capturing variation in technology type, market maturity and national context. The cases are hence not intended to be statistically representative, but analytically relevant for exploring how different types of SMEs encounter similar institutional barriers across the decision-making chain.

The German and Danish case companies are all small and medium-sized enterprises (SMEs) operating within the field of climate adaptation. Across both national contexts, the cases represent variation in technology type, stage of innovation, market maturity and market positioning, while sharing the common condition of operating in highly regulated, public-sector-oriented markets. Analytically, the cases contribute to an understanding of how SMEs are situated in fragmented institutional settings characterised by legal uncertainty, administrative complexity and uneven demand for climate adaptation solutions.

Taken together, the cases represent a broad spectrum of climate adaptation technologies, ranging from nature-based and integrated solutions to sensor-based digital systems and mobile flood protection technologies. This diversity enables comparative analysis

of how different solution types interact with existing planning practices, procurement procedures and local governance structures. Across both countries, the cases provide insight into how regulatory frameworks, municipal planning capacity and companies' ability to establish relations and demonstrate value shape opportunities for early engagement, adoption and implementation. The list of case study interviewees is provided in Appendix 1.

German and Danish case companies

The four German case companies are all SMEs, differing in size, maturity and type of climate adaptation solution offered. Collectively, they illustrate how companies with diverse technological profiles engage with municipal and regional governance structures in Germany.

- **ArborRevital** is a small SME providing sensor-based irrigation management for urban trees through soil moisture measurements combined with digital decision-support tools and tailored tree-care advice.
- **Mobildeich** is an established SME with more than two decades of market experience, specialising in mobile flood protection systems based on flexible, water-filled tubes.
- **Sieker** is an engineering firm offering consultancy and planning services related to rainwater management, sewer optimisation and strategic hydrological planning at multiple spatial scales.
- **WetterWelt** is a private weather service providing digital early warning systems for extreme weather events, targeting municipalities, ports and infrastructure operators.

The six Danish case companies are likewise all SMEs and represent different phases of innovation, from start-ups to established firms and scale-ups. Together, they reflect the diversity of the Danish climate adaptation landscape and offer insight into public-private interaction across planning, procurement and implementation stages.

- **Hidden Dyke** is a start-up SME developing a patented semi-permanent water tube system for coastal protection, currently in a demonstration and visibility-seeking phase.
- **Byggros** is an established SME offering a broad portfolio of green infrastructure solutions, including green roofs and local rainwater management systems, with a strong position in the Danish market.

- **Environment Solution** is a scale-up SME specialising in mobile flood protection systems based on water tube technology, targeting both public authorities and private landowners.
- **Mattle** is a small niche-oriented SME focusing on integrated, life-cycle-based LAR solutions combining soil systems, vegetation and water management.
- **SmartBrønd** is a scale-up SME developing sensor-based systems for urban water management, designed to integrate with existing utility infrastructure.
- **Wintech Engineering** is an established SME with long-standing experience in flood protection technologies, currently adapting its operations to changing market conditions.

Analytical approach

The analysis is structured around the four key stages of the public-sector decision-making chain identified earlier: risk assessment, planning, procurement and implementation. Drawing on semi-structured interviews with ten SMEs across Denmark and Northern Germany, the analysis examines how different types of barriers emerge and interact across these stages. While individual cases are used for illustrative purposes, the analytical patterns presented reflect insights from the full dataset and are selected based on analytical relevance rather than on how frequently similar observations appeared in the material. Because the planning stage represents the central bottleneck in the decision-making chain, where problem framings, solution pathways and budgetary commitments are established, it is examined in greater analytical depth than the other stages. Combining empirical insights with concepts from diffusion of innovation theory and public-sector innovation research, the analysis shows how institutional routines, risk aversion and timing shape the uptake of climate adaptation solutions. Rather than focusing on individual cases, the analysis seeks to identify broader mechanisms that constrain or enable the diffusion of innovative solutions in public-sector markets. Although based on a limited number of cases, these mechanisms are likely to have relevance beyond the specific empirical setting. This is particularly the case in public-sector contexts characterised by complex governance structures and risk-averse decision-making processes.

Results and Discussion

This section presents the results of the analysis and examines how barriers to the diffusion of climate adaptation solutions emerge across the public-sector decision-making chain. While empirical examples are used illustratively, the analysis focuses on identifying cross-case patterns that reveal how institutional barriers systematically shape the diffusion of climate adaptation solutions.

Risk assessment stage

Visibility, communication and trust: The findings indicate that visibility and communication are major barriers for SMEs during the risk assessment stage in both Denmark and Germany. According to diffusion theory, innovations spread more slowly when their benefits are not easily observed and communication channels are limited; especially in public-sector contexts, which often tend to be risk-averse. Before public actors can formally evaluate new solutions, SMEs must first make their technologies visible and understandable. This challenge is illustrated by the German company WetterWelt, which developed an early warning system with clear potential benefits but struggled to gain initial access to municipalities. The traditional way to contact local officials is by phone. Companies often do not know who the right contact person is, making this approach time-consuming and uncertain. Success depends on whether the local authority is genuinely interested in the solution, and many municipalities still do not provide alternative contact channels, such as via websites or social media.

Because ‘cold calling’ was largely ineffective, WetterWelt had to rely on informal entry points to reach municipal decision-makers. For instance, the company attended conferences organized by a tourism director for harbour masters. These events acted as trusted gateways, providing access that direct contact with municipalities could not achieve. This example highlights how SMEs often depend on trusted intermediaries to overcome low visibility and the lack of formal access points. In Rogers’ terms, an innovation does not become visible unless these intermediaries facilitate exposure. Although illustrated here by WetterWelt, similar challenges concerning visibility, communication and access to municipal decision-makers were identified across the interview material, suggesting that

these barriers are not unique to a single company but represent a recurring pattern during the risk assessment stage. More broadly, it illustrates that early-stage barriers are not primarily technological but institutional, rooted in how public-sector organisations structure problem recognition and external communication.

Planning stage

Early engagement as a critical adoption mechanism: Across both countries, the planning stage emerges as the most decisive phase for adoption, confirming the importance of *early engagement* highlighted in the literature on public-sector innovation. It is at this stage that core assumptions, solution pathways and budgetary frameworks are established, often determining which technologies can be considered later in the process. The German engineering firm Sieker provides a clear illustration of this mechanism. The company is frequently involved too late in planning processes and is then expected to act as a ‘fire brigade’ to correct or optimise already-defined solutions. Such late involvement limits the company’s ability to influence system design or introduce more integrated and innovative approaches. Although illustrated by the experience of Sieker, delayed involvement in planning processes was described by several SMEs across both national contexts. This suggests that limited early engagement represents a recurring constraint rather than an isolated case. Analytically, this suggests how exclusion from early planning reinforces *path dependency* and weakens the perceived *relative advantage* of alternative solutions, even when technical expertise is high. The case suggests that barriers at this stage are structurally embedded in municipal planning routines rather than the result of individual resistance.

Delegation of responsibility and risk aversion: The reliance on external advisors during the planning stage functions as a risk management strategy for municipalities but simultaneously creates barriers for SMEs. By relying on external consultants, municipalities may reduce their exposure to uncertainty while potentially narrowing the range of solutions that are actively considered. The Danish case, Wintech Engineering, illustrates how advisors can unintentionally block innovation. Advisors hired by municipalities often lack detailed knowledge of specialised climate adaptation technologies, such as locks and pumping systems, yet still dominate solution selection. This practice shifts

responsibility away from municipal decision-makers and reduces openness to unfamiliar solutions. From a theoretical perspective, this reflects institutional *risk aversion* and reinforces conservative selection mechanisms, consistent with findings by Edler and Georghiou (2007). Advisors thus function not only as technical experts, but also as institutional buffers that stabilise existing solution pathways. Similar concerns regarding advisor dependence and limited openness towards unfamiliar solutions were raised by several interviewees. This indicates that these mechanisms extend beyond the experience of a single company.

Preference for known solutions over relative advantage: Both Danish and German municipalities display strong technology path dependency, favouring familiar solutions even when alternatives offer clear advantages in terms of cost, flexibility or speed of implementation. This tendency is closely linked to organisational norms and perceived accountability within public administrations. A Danish example is provided by Environment Solution, whose mobile water tube systems often are rejected in favour of permanent hard infrastructure. Municipal staff may perceive greater accountability risks if a temporary solution fails, despite the fact that such solutions are often less costly and can be deployed more rapidly. This highlights how perceived risk outweighs *relative advantage* in decision-making and confirms Rogers' (2003) argument that adoption is not driven by technical performance alone. Instead, it is shaped by organisational cultures, accountability structures and fear of blame, which together sustain path dependency.

Procurement stage

Observability and trialability as selection criteria: In the procurement stage, *observability* and *trialability* play a decisive role in whether SMEs are perceived as credible suppliers. Public buyers tend to prefer solutions that can be demonstrated, referenced or visualised, as this reduces uncertainty and perceived risk. The German company Mobildeich demonstrates how high observability can help overcome procurement barriers. The company relies heavily on on-site demonstrations and a large portfolio of reference projects across Europe. These demonstrations reduce uncertainty for public buyers and partially substitute for formal trial phases, which are often difficult to establish within public procurement rules. Across the interviews, respondents

repeatedly emphasised the importance of reference projects, demonstrations and visible performance in establishing credibility within public procurement processes. Analytically, this shows how SMEs could compensate for institutional risk aversion by strengthening observability, thereby facilitating the transition from decision to implementation even in highly regulated procurement environments.

Implementation stage

Compatibility and knowledge transfer: Even when solutions are formally adopted, implementation barriers persist due to limited technical knowledge and weak internal coordination within public organisations. These barriers often emerge at the interface between new technologies and established work practices. The Danish company Mattle illustrates this challenge. Improper handling of specialised soil systems by contractors has led to reduced performance or failure of otherwise well-designed solutions. This reflects a *compatibility barrier*, not between technology and infrastructure, but between innovation and existing operational routines. The case indicates that adoption without sufficient knowledge transfer undermines the potential deployment of mature and reliable technology. Similar implementation challenges related to knowledge transfer and organisational coordination were identified across several companies, suggesting that these barriers are not confined to a specific technology type. More broadly, it shows how implementation failures, viewed through Rogers' diffusion model, can retroactively weaken trust in similar solutions and thereby influence future adoption decisions.

Barriers identified in the decision-making chain

Across the interview material, barriers were identified at all stages of the decision-making chain. However, respondents consistently described the planning stage as the point at which solution pathways, budget allocations and project specifications became sufficiently fixed to constrain later opportunities for innovation. While procurement and implementation barriers remained important, many interviewees emphasised that exclusion from early planning processes significantly reduced the likelihood that alternative solutions would subsequently be considered. Across both Danish and German cases, and across different categories of climate adaptation technologies, respondents

consistently pointed to early planning processes as decisive for subsequent adoption opportunities. The findings therefore suggest that planning barriers are structurally more consequential because they shape the conditions under which later procurement and implementation decisions occur.

The analysis indicates that barriers are present throughout the decision-making chain, but that the planning stage constitutes the most critical bottleneck because key decisions regarding solution pathways and budget allocations are largely established at this point. Once these decisions have been formalised, opportunities for SMEs to influence project design become significantly more limited. Consequently, barriers encountered during procurement and implementation often reflect constraints that have already been embedded during earlier planning processes.

The findings furthermore illustrate how diffusion mechanisms are embedded within public-sector governance processes. While planning routines, procurement rules and organisational structures shape opportunities for adoption, diffusion theory helps explain *why* certain solutions struggle to progress through these institutional settings. Relative advantage, observability, trialability and compatibility therefore operate not as isolated technological characteristics, but as factors that interact with governance structures throughout the decision-making chain. This interaction between governance structures and diffusion mechanisms is particularly evident in the planning stage. As shown above, planning processes determine not only which solutions are considered, but also whether SMEs gain access to decision-makers at a sufficiently early stage to demonstrate the value of their innovations. Early engagement therefore emerges as a key mechanism linking institutional decision-making processes with the diffusion of climate adaptation solutions.

According to diffusion of innovation theory, *early engagement* is thus important because it enables potential adopters to assess new solutions before planning frameworks and project specifications become fixed. However, many companies find this difficult, as they are often excluded from planning processes unless they possess established networks or prior relationships with municipalities and utilities. By the time they try to enter the market, many choices have already been made and planned for, often based on advice from

external consultants, or on solutions that municipalities already know. Some companies manage to take an active part by assisting in preparing the tender materials. This can be a clear advantage, as it gives them a better chance of being chosen later. This is, however, not the case for all SMEs, and many companies do not have access to that part of the process.

Even when a solution has a clear relative advantage - for example if it is less costly or easier to install - it is not always selected. In the procurement stage, for example, *observability* is important, but some climate adaptation solutions are hidden underground. Municipalities and/or utilities however would like to see how a solution works, before they purchase it, which can be a hard task for new or certain types of companies. *Trialability* is also important, and some companies manage to test their solutions on their own, for example through demo sites or small-scale projects. The empirical data also shows that it can be difficult to test new solutions in *collaboration* with municipalities, where it could make a real difference for later uptake. The rules are unclear, the paperwork is heavy and municipalities are often afraid of doing something wrong, hence *risk aversion*. This means that even good solutions are not tested in real public settings before being ruled out.

Another challenge is *compatibility*. Thus, many company solutions do not fit with the way municipalities work. Some adaptation solutions cross over different sectors and apply a combination of solutions, which does not fit into silo-based ways of working. They may not match existing budgets, routines or department structures etc., creating *regulation and administration barriers*. Complexity can also be a barrier, where some solutions are hard to understand or explained in technical ways that confuse the customers. It is not always due to the solution being too advanced, but simply that they are unfamiliar. Even when early engagement happens, and a solution has reached the implementation stage, it may not be followed up by relevant staff members. Thus, municipalities do not always share knowledge between departments in their planning or use the solution in later projects. This again implies, that the *observability* of the adaptation solution stays low, and that the companies do not benefit from the first success.

Taken together, the findings suggest that barriers to climate adaptation are not only institutional in nature, but also stage-specific and unevenly distributed

along the public-sector decision-making chain. Rather than operating as isolated obstacles, different barriers become more or less influential across successive stages, highlighting how opportunities for innovation adoption are shaped by earlier decisions and institutional routines. While previous studies have identified a broad range of adaptation barriers (Moser and Ekstrom, 2010; Eisenack et al., 2014), the present study suggests that these barriers do not exert equal influence throughout the decision-making process. Instead, their significance depends on organisational routines and access to key decision arenas. Innovation uptake is therefore shaped less by technological performance alone and more by institutional positioning and opportunities for early engagement. These findings suggest that barriers to climate adaptation are best understood as stage-specific mechanisms embedded within institutional decision-making processes, thereby shifting attention from the existence of barriers towards their stage-specific and institutional positioning within the public-sector decision-making chain.

The study also illustrates that different actor groups occupy distinct positions within the decision-making chain and therefore influence innovation adoption in different ways. Municipalities and utilities typically act as project owners and decision-makers, while external advisors often play an important role in shaping problem definitions, technical specifications and solution assessments during the planning stage. SMEs, in contrast, primarily participate as solution providers seeking access to decision-making processes. Although the present study does not aim to systematically compare these actor groups, the findings suggest that barriers to innovation adoption emerge through interactions between actors with different responsibilities, incentives and levels of influence. This highlights the importance of understanding climate adaptation governance as a multi-actor process rather than as the product of a single public-sector decision-maker.

Limitations

Several limitations should be acknowledged in this study. *First*, the study is based on a relatively small sample of ten SMEs and therefore aims for analytical rather than statistical generalisation. *Second*, the empirical material reflects the perspectives of solution providers

only and does not include interviews with municipalities, utilities, consultants or procurement officers involved in the decision-making process. Consequently, the findings may reflect experiences and interpretations specific to SME actors and should not be understood as direct representations of the perspectives of municipalities, utilities or external advisors. *Third*, the study focuses on Denmark and Northern Germany, implying that findings may be influenced by characteristics specific to these institutional contexts. Finally, although recurring patterns were identified across interviews, qualitative interpretations inevitably involve a degree of researcher judgement. The findings should therefore be understood as theoretically informed explanations of how barriers emerge across the decision-making chain rather than as definitive representations of all public-sector climate adaptation processes.

Conclusion

Climate adaptation solutions are increasingly available, ranging from digital monitoring systems and sensor technologies to mobile flood protection measures, nature-based solutions and integrated water management approaches (Seidu et al., 2025; Ayadi et al., 2025). However, their uptake in public-sector contexts remains constrained by institutional and organisational barriers rather than by technological limitations alone (Audate et al., 2025; Biswas et al., 2022; Colocci et al., 2025). Based on interviews with Danish and German SMEs, this study suggests that barriers to adoption are unevenly distributed across the public-sector decision-making chain. While barriers occur throughout the stages of risk assessment, planning, procurement and implementation, the planning stage emerges as the most critical bottleneck. It is at this stage that solution pathways, project specifications and budgetary priorities are established. As a result, exclusion from early planning reinforces path dependency and significantly reduces the likelihood that alternative solutions will be considered.

The findings contribute to climate adaptation governance and innovation diffusion research by illustrating how previously identified barriers become more or less influential across different stages of the public-sector decision-making chain and how these barriers are shaped by institutional decision-making processes.

More specifically, the analysis shows how institutionalised decision-making routines structure when, how and by whom innovative solutions are considered. By combining diffusion of innovation theory (Rogers, 2003) with insights from public-sector innovation research (Edler and Georghiou, 2007; Uyarra et al., 2014), the study illustrates how relative advantage, observability, trialability and compatibility interact with governance structures, organisational routines and risk management practices. The findings therefore contribute to diffusion research by highlighting the importance of timing, institutional positioning and early engagement in shaping adoption outcomes. The findings further suggest that barriers emerge through interactions among multiple actors involved in climate adaptation decision-making, including municipalities, utilities, external advisors and SMEs, each occupying different positions within the decision-making chain.

From a policy perspective, the findings suggest that more open and inclusive planning processes allowing earlier interaction between public authorities and SMEs may facilitate the uptake of innovative climate adaptation solutions. This observation supports recent research highlighting the importance of involving SMEs more actively in adaptation governance and decision-making processes (Eadson et al., 2026), particularly given their role in providing specialised technical and context-specific knowledge for climate adaptation

(Smith et al., 2025). The findings indicate that creating opportunities for dialogue before project specifications become fixed may improve the consideration, testing and adoption of innovative climate adaptation solutions. Future research should explore how institutional reforms, experimental governance arrangements and procurement practices may reduce barriers and support wider diffusion of climate adaptation technologies across different national and sectoral contexts.

More broadly, the study suggests that climate adaptation barriers are best understood as stage-specific and institutionally embedded mechanisms rather than as isolated factors. The findings indicate that innovation uptake is shaped less by technological characteristics alone than by organisational routines, institutional positioning and access to early planning arenas. Future research should therefore pay greater attention to the sequential and institutional nature of adaptation processes and to how different actor groups influence opportunities for innovation throughout the decision-making chain.

Acknowledgement

This paper is based on research funded by the EU-Interreg project 'Poseidon' (Funding nr. 03-2.2-232 [24/2390]) running from 2024–2027. The research project entails a cross-border study of innovation barriers and possibilities related to climate adaptation technology between Germany and Denmark.

References

- Ayadi R., Forouheshfar Y. and Moghadas O. (2025) Enhancing system resilience to climate change through artificial intelligence: A systematic literature review. *Frontiers in Climate* 7: 1585331. Available at: <https://doi.org/10.3389/fclim.2025.1585331>
- Audate P.P., Boivin M., Cloutier G. (2025) Multi-level barriers and opportunities for urban greening and depaving initiatives as climate change adaptation measures: Quebec City case study. *Urban Forestry & Urban Greening* 112: 128947. Available at: <https://doi.org/10.1016/j.ufug.2025.128947>
- Biesbroek G. R., Klostermann J. E. M., Termeer C. J. A. M. and Kabat P. (2013) On the nature of barriers to climate change adaptation. *Regional Environmental Change* 13(5): 1119–1129. Available at: <https://doi.org/10.1007/s10113-013-0421-y>
- Biswas R.R., Sharma R., Gyasi-Agyei Y. (2022) Urban water crises: Making sense of climate change adaptation barriers and success parameters. *Climate Services* 27: 100302. Available at: <https://doi.org/10.1016/j.cliser.2022.100302>
- Braun V. and Clarke V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology* 3(2): 2006. Available at: <https://doi.org/10.1191/1478088706qp0630a>
- Buga N. and Yousif C. (2021) Evaluating drivers and barriers to adopting a local energy policy under The Covenant of Mayors Initiative in the Small Island State of Malta. *Energy Policy* 159: 112586. Available at: <https://doi.org/10.1016/j.enpol.2021.112586>
- Colocci A., Pietta A., Caviglia F., Bagliani M. (2025) Fostering climate change adaptation through local authority efforts: Insights from the case study of Genoa. *Environmental Development* 55: 101221. Available at: <https://doi.org/10.1016/j.envdev.2025.101221>
- Colgan W., Henriksen H. J., Bennike O., Riberio S., Keiding M., Karlsson Seidenfaden I., Graversgaard M., Busck A. G., Fruergaard M., Knudsen M. H., Hopper J., Sonnenborg T., Skjærbæk M. R., Bjørk A. A., Steffen H., Tarasov L., Nerem R. S. and Kjeldsen K. K. (2022) Sea-level rise in Denmark: paleo context, recent

- projections and policy implications. *GEUS Bulletin* 49. Available at: <https://doi.org/10.34194/geusb.v49.8315>
- de Bruyn C., Said F.B., Venter M., Castanho R.A. (2026) Are smart technologies enough to build climate-resilient cities? Insights from 15 years of global research. *City and Environment Interactions* 100306. Available at: <https://doi.org/10.1016/j.cacint.2026.100306>
- Eadson W., Hampton S., Blundel R., Apostolopoulou E., Latter B., Witherley D., Hardy-Jones B., Sugar K. (2026) Just business? Rethinking the role of small and medium enterprise climate action through a just transition lens. *Energy Research & Social Science* 131: 100480. Available at: <https://doi.org/10.1016/j.erss.2025.104480>
- Edler J. and Georghiou L. (2007) Public procurement and innovation - Resurrecting the demand side. *Research Policy* 36(7): 949–963. Available at: <https://doi.org/10.1016/j.respol.2007.03.003>
- Edquist C. and Zabala-Iturriagagoitia J.M. (2012) Public Procurement for Innovation as Mission-Oriented Innovation Policy. *Research Policy* 41(10): 1757–1769. Available at: <https://doi.org/10.1016/j.respol.2012.04.022>
- Eisenack K., Moser S. C., Hoffmann E., Klein R. J. T., Oberlack C., Pechan A., Rotter M. and Termeer C. J. A. M. (2014) Explaining and overcoming barriers to climate change adaptation. *Nature Climate Change* 4(10): 867–872. Available at: <https://doi.org/10.1038/nclimate2350>
- EC (European Commission) (2013) *An EU strategy on adaptation to climate change* (COM(2013) 216 final). European Commission. Available at: https://climate.ec.europa.eu/eu-action/adaptation-and-resilience-climate-change/eu-adaptation-strategy_en
- EC (European Commission) (2021) *Forging a climate-resilient Europe - the new EU strategy on adaptation to climate change* (COM(2021) 82 final). European Commission. Available at: https://climate.ec.europa.eu/eu-action/adaptation-and-resilience-climate-change/eu-adaptation-strategy_en
- EEA (European Environment Agency) (2025) *National adaptation policies and actions in Europe: 2025 update*. European Environment Agency. Available at: <https://www.eea.europa.eu/en/topics/in-depth/climate-change-adaptation>
- EU (European Union) (2021) *Regulation (EU) 2021/1119 of the European Parliament and of the Council establishing the framework for achieving climate neutrality (European Climate Law)*. *Official Journal of the European Union* L243: 1–17. Available at: <https://eur-lex.europa.eu/eli/reg/2021/1119/oj>
- Georghiou L., Edler J., Uyarra E. and Yeow J. (2014) Policy Instruments for Public Procurement of Innovation: Choice, Design and Assessment. *Technological Forecasting and Social Change* 86: 1–12. Available at: <https://doi.org/10.1016/j.techfore.2013.09.018>
- IPCC (2021) *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp. Available at: <https://doi.org/10.1017/9781009157896>
- Kvale S. and Brinkmann S. (2015) *InterViews: Learning the craft of qualitative research interviewing* (3rd ed.). Thousand Oaks, CA: SAGE Publications.
- Larsen M.A.D., Karamitilios G., Halsnæs K., Madsen K.S. (2021) Advancing future climate services: Multi-sectorial mapping of the current usage and demand in Denmark. *Climate Risk Management* 100335. Available at: <https://doi.org/10.1016/j.crm.2021.100335>
- Lange A., Ebert S., Vetter A. (2021) *Adaptation Requires Participation: Criteria and Factors for Successful Stakeholder Interactions in Local Climate Change Adaptation*. Springer Nature. Available at: https://doi.org/10.1007/978-3-030-22759-3_47-1
- Lybæk R. and Grindsted T.S. (2025) Assessment and Identification of Requests for Technology and Innovation Needs within the Danish DK2020 Climate Action Plans. *International Journal of Advanced Multidisciplinary Research and Studies* Volume 5, Issue 1: 2025. Available at: <https://doi.org/10.62225/2583049X.2025.5.1.3674>
- Mehvar S., Brugge A., Murukannaiah P., Jonker C., Daamen T. (2025) Transdisciplinary knowledge production for integrated climate risk Management: Application of a framework in the Dutch urbanized delta. *Climate Risk Management* 2025: 100773. Available at: <https://doi.org/10.1016/j.crm.2025.100773>
- Mernild S. (2025) *Climate Assessments from Global to Regional InterReg Scales*. SDU published, Denmark. Available at: <https://nextcloud.sdu.dk/index.php/s/AnLWYJ5X8F3RSHp>
- Moser S. C. and Ekstrom J. A. (2010) A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences* 107(51): 22026–22031. Available at: <https://doi.org/10.1073/pnas.1007887107>
- Pietrapertosa F. (2023) Adaptation to climate change in cities of Mediterranean Europe. *Cities* 140 (2023): 104452. Available at: <https://doi.org/10.1016/j.cities.2023.104452>
- Rimlinger J., Jaumouillé A., Freissinet C., Craveiro J.L., Zózimo A.C., Oliveira M.M., Cruz M.M., Bakogianni E., Tzempelikos D., Pavlidi E., Sfetsos A. (2026) Shaping local disaster risk governance through multi-stakeholder collaboration: Insights from the public-private-civil partnership approach - Application to the case studies of the municipality of Egaleo (Greece) and Centro Region (Portugal). *International Journal of Disaster Risk Reduction* 133: 105973, ISSN 2212-4209. Available at: <https://doi.org/10.1016/j.ijdrr.2025.105973>

Rogers E. M. (2003) *Diffusion of Innovations* (5th ed.). New York: Free Press. ISBN: 0-7432-5823-1.

Saldaña J. (2016) *The Coding Manual for Qualitative Researchers*. 3rd ed. Thousand Oaks, CA: Sage. Available at: <https://doi.org/10.1108/QR0M-08-2016-1408>

Seidu S., Chan David D.W.M., Edwards J., Owusu-Manu D. (2025) A systematic review of green infrastructure and ecosystem-based technologies for climate resilience: development trends, research outlook and future projections. *Environ. Res. Lett.* (20): 083001. Available at: <https://doi.org/10.1088/1748-9326/ade730>

Smith A.J.P., Minns A., Nicholls R.J., Beswick A., Jenkins K., Avrutin S., Robson C. (2025) Reflections on delivering place-based climate risk data in support of local adaptation decisions. *Climate Risk Management* 48: 100701. Available at: <https://doi.org/10.1016/j.crm.2025.100701>

Tahereh Z. and Nadejda K. (2025) Comparative analysis of adaptation policies and policy instruments for water management in Europe. *Journal of Hydrology: Regional Studies* (62). Available at: <https://doi.org/10.1016/j.ejrh.2025.102819>

Trautmann C. and Siegmund A (2021) Förderung der Handlungsfähigkeit von Auszubildenden für die betriebliche Klimaanpassung. *Standort* 45(2): 1-8. Available at: <https://doi.org/10.1007/s00548-021-00741-7>

Uyarra E., Edler J., Garcia-Estevéz J., Georgiou L. and Yeow J. (2014) Barriers to innovation through public procurement: A supplier perspective. *Technovation* 34(10): 631-645. Available at: <https://doi.org/10.1016/j.technovation.2014.04.003>

Wise R. M., Fazey I., Stafford Smith M., Park S. E., Eakin H. C., Archer Van Garderen E. R. M. and Campbell B. (2014) Reconceptualising adaptation to climate change as part of pathways of change and response. *Global Environmental Change* 28: 325-336. Available at: <https://doi.org/10.1016/j.gloenvcha.2013.12.002>

Ye X., Chen Y., Sheng J., Wang W. (2026) An overview of climate change adaptation and mitigation research in architecture heritage. *Energy and Buildings* 351(15): 116680. Available at: <https://doi.org/10.1016/j.enbuild.2025.116680>.

Yin R. K. (2018) *Case study research and applications: Design and methods* (6th ed.). Thousand Oaks, CA: SAGE Publications.

Appendix 1. Case study interviewees

Company	Interviewee	Interview date
ArborRevital	Sternberg	April 2025
Byggros	Stall-Thomsen	April 2025
Environment Solution (No-Floods)	Phillipsen	June 2025
Hidden Dyke	Gramkow	May 2025
Mattle	Mattle	May 2025
Mobildeich	Kock	May 2025
Sieker	Pallasch	June 2025
SmartBrønd	Preis	May 2025
WetterWelt	Müggenburg	June 2025
Wintech Engineering	Bach	June 2025



This article is an Open Access article distributed under the terms and conditions of the Creative Commons Attribution 4.0 (CC BY 4.0) License (<http://creativecommons.org/licenses/by/4.0/>).