Exploring How Digital Inclusion Initiatives Can Support Locally-led Climate Change Adaptation: Challenges and Recommendations

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Abstract

Digital inclusion has become a critical enabler of equitable development and adaptive capacity, particularly for rural and underserved communities facing the impacts of climate change. This study examines the role of Union Digital Centers (UDCs) in Bangladesh as a case study to explore how digital inclusion initiatives can support locally-led climate change adaptation. Using observations and interviews with UDC staff and service users, the research examines the current scenario, gaps, and potential of these centers in helping bridge digital divides and empower local communities to address climate-related challenges. The study finds that while these initiatives act as information hubs and can support capacity development, knowledge gaps, unfulfilled resource needs, and weak collaboration act as key challenges. Drawing on these findings, the paper discusses how digital inclusion initiatives can support locally-led adaptation and suggests recommendations. Fostering participatory planning, tailoring digital services to community-specific needs, and promoting inclusive governance to ensure equitable access and involvement are some of the key recommendations. The paper provides actionable recommendations for policymakers and government practitioners, with a focus on strengthening the role of digital inclusion in fostering adaptive capacity. By addressing gaps in current practices and policy, this research contributes to advancing digital inclusion as a tool for supporting vulnerable communities' efforts to adapt to climate change.

Keywords: digital inclusion, digital divide, union digital centers, locally-led adaptation, climate change adaptation

Introduction

The worsening climate change is predicted to reverse the benefits of development, harm many important industries, and even endanger many lives (Pachauri et al., 2014), which necessitates an increased focus on climate change adaptation. As the negative impacts of climate change disproportionately affect the disadvantaged population, adaptation efforts must enable communities and enhance human welfare (Beauchamp et al., 2021). As per the Global Center on Adaptation (2019), “people and communities on the frontlines of climate change are often the most active and innovative in developing adaptation solutions yet lack access to the resources and power needed to implement solutions.” The literature regarding climate change adaptation shows a shift from community-based adaptation to locally-led adaptation (Vincent, 2023; Westoby et al., 2020). The idea of locally-led adaptation promotes equity and inclusivity, control by local people, and encourages adaptation efforts to be grounded in local realities (M. F. Rahman et al., 2023; Westoby et al., 2021). Locally-led adaptation is guided by eight principles, including devolving decision-making, addressing structural inequalities, accessible funding, investing in local capabilities, building understanding of climate risk, flexible programming, ensuring accountability, and collaborative action (Soanes et al., 2021). Capacity building, ensuring access to information and technology, addressing vulnerabilities, and providing support for growth are therefore necessary for locally-led adaptation to succeed (Westoby et al., 2021). For example, Grossi and Dinku (2022) explored how participatory use of climate information can improve the ability of users to demand the services they need, thereby contributing to locally-led adaptation.

On the other hand, the increasing digitalization of the world is being juxtaposed with another problem – the digital divide. While many digital inclusion initiatives are being undertaken to solve this problem, challenges remain. One of these digital inclusion initiatives is Union Digital Centers (UDCs), which are information service centers based at the union level in Bangladesh. However, Bangladesh is not only highly vulnerable to climate change but is also characterized by a lack of human development, inequality, lack of access to information, and a high digital divide (Waughen, 2015), all of which are hindrances to climate change adaptation. UDCs, which are information service centers based at the union level, have been contributing significantly to reducing this digital divide and facilitating sustainable development at the local level (Md. R. Hoque et al., 2022). The evidence shows that these UDCs have been facilitating rural development (M. Rahman et al., 2020), empowering the rural people (Hosen et al., 2022), contributing to women empowerment (Akter & Husain, 2021), and many more. These digital inclusion initiatives can allow the most vulnerable people to access information, develop their capacity, and access resources and

services, which are necessary for facilitating climate change adaptation. However, no research paper has linked the concepts of digital inclusion initiatives and locally-led adaptation. This proposed paper attempts to fill this gap by exploring how digital inclusion initiatives, as exemplified by UDCs, can support locally-led adaptation. The specific aims of this paper are:

1. To explore how digital inclusion initiatives, exemplified by Union Digital Centers (UDCs) in Bangladesh, can contribute to locally-led climate adaptation efforts; and
2. To suggest recommendations on how digital inclusion initiatives can better support locally-led climate adaptation.

Literature Review

Digital Inclusion and the Digital Divide

The digital divide, which can be described as a disparity in access to and use of information and communication technologies, remains a significant global challenge, impeding equitable access to opportunities in education, employment, and civic participation. Digital inclusion initiatives aim to bridge these gaps by addressing not only access but also socio-economic, cultural, and cognitive barriers. Across the literature, digital inclusion initiatives are seen as a means to access information and communication technologies (ICTs), emphasizing the importance of equitable access and the ability to utilize digital tools effectively. Alhassan and Adam (2024) underscore the empirical connection between ICT policies, digital inclusion, and sustainable development, highlighting how ICT access and use enable individuals to engage in information sharing and promote sustainable urban development. Similarly, Charleson (2012) highlights the transformative potential of digital media production in empowering marginalized individuals, arguing that active engagement with technology, beyond mere access, is vital to bridging the digital divide. However, challenges remain, as many of the previous studies (Clayton et al., 2015; Park, 2017) point out that digital exclusion often mirrors existing social inequalities, including socioeconomic status and geographical remoteness. This exclusion disproportionately impacts disadvantaged groups, suggesting that interventions must address both technological infrastructure and socioeconomic barriers.

Studies also show that digital inclusion is deeply intertwined with cultural and contextual factors. Correa and Pavez (2016) illustrate how geographical isolation and demographic challenges

shape attitudes toward technology in rural Chilean communities, complicating efforts to integrate ICTs. This aligns with Madon et al. (2009), who identify community acceptance, social engagement, and institutional support as crucial for the success of digital inclusion projects in developing countries. Nemer (2015) further expands this perspective, advocating for a multifaceted approach that considers cognitive, economic, cultural, and social dimensions of access, moving beyond a simplistic focus on infrastructure. Meanwhile, initiatives such as those discussed by Rao (2005) in India and Zheng et al. (2024) in rural China demonstrate how tailored digital inclusion efforts can foster economic opportunities and social development, particularly in rural areas. These findings emphasize that bridging the rural-urban digital divide requires not only technological interventions but also educational initiatives to enhance digital literacy and skills.

Despite its potential, digital inclusion efforts often risk being co-opted by economic and political agendas, as Wiig (2016) critiques in the context of smart city initiatives. Projects marketed as transformative often fail to address systemic urban inequalities, prioritizing economic development over social equity. Similarly, Ragnedda and Mutsvairo (2018) argue that digital inclusion policies must consider local social and cultural contexts to avoid reinforcing existing disparities. This notion is supported by Celestino and Valente (2022), who caution that digital exclusion can compromise the achievement of sustainable development goals, particularly in countries like Brazil, where systemic inequities remain prevalent. Collectively, the literature has been calling for a global e-inclusion movement (Molina, 2003) that integrates technological, economic, and social strategies to ensure digital access and empowerment for all. By addressing structural inequities and fostering inclusive participation, digital inclusion can serve as a catalyst for broader societal transformation.

Union Digital Centers (UDCs)

Union Digital Centers (UDCs) in Bangladesh have been pivotal in bridging the digital divide and fostering rural development by providing digital services at the grassroots level. Established under the Digital Bangladesh initiative, UDCs aim to enhance accessibility to government services and information for rural populations. Scholars have examined the transformative potential of UDCs, highlighting their role in reducing social inequalities by democratizing access to digital tools and services (Abedin et al., 2021). They have also contributed to women’s empowerment, enabling rural women to access critical information and resources, thereby fostering autonomy and participation in community decision-making (Akter & Husain, 2021). Despite their achievements,

challenges to UDC sustainability and service delivery persist. Concerns about financial viability have been raised, with studies emphasizing the need for diversified income sources and stronger institutional support to ensure their longevity (Faroqi, 2015; Mamun & Begum, 2018). Service quality and user satisfaction have emerged as critical factors influencing citizens' intentions to engage with UDCs, with active citizen participation identified as a moderating variable (Biswas & Roy, 2020). Moreover, UDCs have been instrumental in promoting good governance by improving transparency and efficiency in service delivery, though users' perceptions of governance outcomes remain mixed (S. M. S. Hoque, 2020).

In rural areas, UDCs have demonstrated their capacity to empower citizens by offering one-stop access to digital services and fostering a sense of inclusion in governance processes (Hosen et al., 2022; M. Rahman et al., 2020). However, limitations such as inadequate infrastructure, lack of technical expertise, and insufficient awareness among rural populations have impeded their effectiveness (Islam & Islam, 2018). Reports published in the media have pointed to a decline in public enthusiasm for UDCs, attributing it to inconsistent service delivery and evolving community needs, underscoring the urgency for structural and operational reforms (Hossen, 2024; Jahan, 2023). Scholars advocate for innovative approaches to sustain and expand UDCs, such as further leveraging public-private partnerships to enhance financial and operational efficiency (S. M. A. Rahman, 2016). Additionally, tailoring services to local needs, particularly in sectors like agriculture, has been suggested as a strategy to maximize their impact (Mondal et al., 2023). These findings underscore the complex interplay between the opportunities and challenges UDCs face in advancing digital inclusion and development in Bangladesh.

Locally-led Climate Change Adaptation

Locally-led adaptation (LLA) is an increasingly prominent approach in addressing the effects of climate change, particularly in regions vulnerable to its impacts. This approach emphasizes the importance of local knowledge, empowerment, and decision-making in adapting to climate risks. This deviates from previous ideas on climate change adaptation in that it puts local actors at the front and center of the solution. Central to LLA is the idea that adaptation efforts should not be imposed from above, but should be shaped by the priorities and capacities of local actors. This concept is supported by the growing recognition that climate impacts are most acutely felt at the local level, where adaptation strategies must be context-specific and responsive to local needs.

One of the key arguments in favor of LLA is that it enhances the effectiveness of adaptation by aligning strategies with local knowledge and priorities. As highlighted by Ayers (2010), global climate change adaptation policies often fail to integrate local perspectives, which can lead to ineffective or inappropriate interventions. The shift toward locally-led approaches is seen as a way to ensure that adaptation strategies are not only more relevant but also more sustainable. Beauchamp et al. (2021) argue that locally-led adaptation in Tanzania, for instance, results in better outcomes for resilience and wellbeing because it is designed with the active involvement of local communities. Similarly, Westoby et al. (2020) demonstrate that locally-led initiatives in Vanuatu allowed for more contextually appropriate and sustainable climate adaptation strategies than community-based efforts that lacked local control.

Another critical aspect of LLA is its focus on equity and inclusion. Local actors, especially those in marginalized communities, often face the greatest vulnerability to climate change but are typically excluded from decision-making processes that shape adaptation strategies. LLA addresses this issue by decentralizing decision-making and ensuring that vulnerable groups have a voice in the design and implementation of adaptation measures. For example, Dinshaw et al. (2023) call for enabling local actors to make key adaptation decisions and lead adaptation action. In doing so, LLA helps to rectify the historical and ongoing inequities faced by marginalized communities, enabling them to better cope with climate impacts. LLA also encourages the use of Nature-based Solutions (NbS), which are strategies that work with natural processes to address climate impacts. These solutions are increasingly recognized for their potential to provide sustainable and cost-effective adaptation options. Bedelian et al. (2024) highlight the role of NbS in water adaptation in East Africa, emphasizing how they can be integrated into locally-led projects to increase resilience and improve environmental outcomes. Similarly, M. F. Rahman et al. (2023) argue that NbS, when implemented locally, can provide multiple benefits, including reducing deforestation and enhancing biodiversity, thus contributing to both climate adaptation and mitigation goals.

Finance is another critical element in the success of LLA. Traditional adaptation funding mechanisms are often centralized, which can delay or limit the allocation of resources to local projects. The Global Center on Adaptation (2019) argues that decentralizing financial flows is essential for enabling effective and equitable adaptation at the local level. Coger et al. (2022) further suggest that local governments play an important role in managing adaptation finance and that their involvement in decision-making processes ensures that resources are better allocated to local needs. Furthermore, the report on locally-led adaptation in East Africa's water sector by

Bedelian et al. (2024) underscores the importance of aligning financial mechanisms with LLA principles to ensure that funding reaches local communities in a timely and effective manner. Moreover, monitoring and evaluation (M&E) systems tailored to locally-led adaptation are vital to ensure the continued success and sustainability of adaptation initiatives. The role of M&E is not only to track progress but also to empower local communities to assess and adjust their adaptation strategies as needed. Coger et al. (2021) suggest that a more inclusive, context-aware approach to M&E can help to overcome power imbalances, ensuring that local priorities are reflected in the evaluation process. This adaptive, locally-driven M&E process is essential for building long-term resilience, as it allows communities to respond flexibly to changing circumstances.

LLA is an approach that prioritizes local knowledge, equity, and empowerment in addressing climate change. By decentralizing decision-making, finances, and control over adaptation strategies, LLA offers a more sustainable and effective way to build resilience in vulnerable communities. However, the success of this approach requires concerted efforts to address challenges related to finance, governance, and the integration of local knowledge, as outlined in the literature on LLA. By focusing on these key areas, locally-led adaptation can help ensure that adaptation efforts are both locally relevant and globally effective.

Digital Inclusion and Climate Change Adaptation

While there is a severe lack of research that explores the intersection of these two important issues, there are some papers and reports that attempt this. Some papers acknowledge that digital inclusion can play a crucial role in enhancing climate change adaptation by addressing disparities in access to information and resources, which are often exacerbated by the digital divide. As Cooper (2023) emphasizes, communities without reliable internet access or digital literacy are at a significant disadvantage in responding to climate risks, unable to leverage digital tools for early warnings or adaptation planning. Similarly, Hagerty (2023) links digital exclusion to heightened climate vulnerability, noting that marginalized groups often lack the technological infrastructure necessary to engage in adaptive strategies or access real-time information during climate crises. Larroquette and Otsuka (2021) further underscore that bridging the digital divide is essential for fostering global collaboration and enabling grassroots climate action, as equitable access to digital technologies empowers communities to implement localized, technology-driven solutions.

Some of the literature showcases the potential and challenges of digital inclusion in addressing climate adaptation issues by different means. Eakin et al. (2015) highlight the transformative potential of information and communication technologies (ICTs) in climate adaptation across Latin America and the Caribbean, where digital tools have been instrumental in improving climate data dissemination, fostering collaboration, and supporting decision-making. Yet, as Gain and Fritsch (2024) argue, achieving this potential requires targeted efforts to address digital disparities, which otherwise hinder effective environmental management. Eichberger and Guerdjikova (2012) also note that technology adoption is influenced by socio-economic and institutional factors, suggesting that strategies for adaptation must consider not only access to digital tools but also the capacity of users to effectively utilize them. Dwivedi et al. (2022) expand this discussion by exploring how digital technologies can simultaneously mitigate and exacerbate climate challenges, calling for a balanced approach to leverage technology without deepening existing inequalities. Roome (2016) points out that addressing the digital divide is not merely about providing access to technology but also about fostering the skills and resources needed to adapt to climate impacts. This view aligns with the arguments of Hagerty (2023), who says that inclusive digital policies can reduce systemic vulnerabilities by ensuring marginalized populations are equipped to participate in digital adaptation efforts.

Taken together, the literature suggests that digital inclusion is both a precondition and a pathway for effective climate change adaptation, necessitating comprehensive strategies that bridge digital gaps and empower communities to harness technology for resilience-building. However, we can see that despite different disconnected papers hinting at the potential of digital inclusion for enhancing climate change adaptation, there have been no systematic studies that have explored this potential. This paper attempts to fill this gap by providing a conceptual link between the ideas, supported by insights from a case study.

Theoretical Background

Sen’s Capability Approach

The Capability Approach, introduced by Amartya Sen, can be viewed as a framework for evaluating well-being, social arrangements, and development policies. It focuses on what individuals can do and be and the real opportunities available to them (or their "capabilities") to achieve lives they have reason to value. Unlike traditional metrics, such as income or utility, this

approach prioritizes individual freedoms and the means to enhance them. Sen emphasizes that development should be about expanding substantive freedoms, enabling people to achieve their potential and make meaningful choices. The approach is multidimensional, addressing inequalities not only in outcomes but also in the conditions enabling people to pursue those outcomes. It also highlights the interplay of personal, social, and environmental factors in shaping opportunities (Comim et al., 2008).

Different papers have discussed how this theory or approach contributes to the ideas and practices surrounding development. For example, Alkire (2005) argues that this framework allows a more nuanced and inclusive evaluation of well-being by emphasizing people's real opportunities to achieve valued outcomes. Moreover, Frediani (2010) highlights its participatory nature, which involves stakeholders in identifying the capabilities that matter most to them. This participatory dimension ensures that development interventions are aligned with the priorities and values of the communities they target. By prioritizing locally defined aspirations, the approach fosters more context-sensitive and inclusive development. Robeyns (2005) discusses this approach's commitment to prioritizing capabilities over resources or utility, emphasizing its flexibility in adapting to various contexts. Furthermore, Wells (2011) highlights its potential for addressing structural inequalities, particularly by identifying and removing barriers that limit individuals' capabilities. He sees the approach as a powerful tool for advocating policies that enhance equity and justice, particularly for disadvantaged groups.

Many papers have utilized the valuable lens provided by Sen's Capability Approach to understand and explore digital inclusion, emphasizing the enhancement of individual freedoms and opportunities to live meaningful lives. For example, Fisk et al. (2023) explicitly connect the Capability Approach to digital inclusion, framing it as a means to "heal the digital divide" by enhancing human capabilities. They argue that digital inclusion is not merely about providing access to digital tools but about enabling individuals to achieve valued outcomes, such as education, health, and social participation. Their work underscores the role of service ecosystems in creating inclusive digital environments, highlighting that true inclusion arises when digital technologies are leveraged to empower individuals, particularly those from marginalized communities, to achieve substantive freedoms. Moreover, M. R. Hoque (2020) examines how access to information and communication technology (ICT) can expand opportunities for education, livelihood, and social interaction, thereby contributing to sustainable development. The focus on expanding real freedoms aligns closely with the Capability Approach's emphasis on enabling individuals to convert resources into valuable capabilities. Poveda (2016) explores digital

inclusion programs in Brazil, demonstrating how such initiatives can promote social change when grounded in the principles of the Capability Approach. This highlights how digital inclusion fosters "conscientization" by empowering individuals to reflect critically on their social realities and act toward change. Tshivhase et al. (2016) provide a broader review of the application of the Capability Approach in ICT4D projects, identifying its utility in framing digital inclusion initiatives that prioritize human development over technological determinism. They note that the approach helps to reveal inequalities in access, use, and benefits, emphasizing that technological solutions must be coupled with strategies to overcome social and institutional barriers. Overall, this framework can explain the link between enabling individuals to access and effectively use digital technologies and the broader societal, personal, and structural factors that influence well-being.

Resilience Theory

Resilience theory provides a framework for understanding the ability of systems, including ecological, social, or organizational systems, to absorb disturbances and reorganize while changing, yet still retain their essential functions, structure, identity, and feedback mechanisms. This theory emphasizes adaptation, flexibility, and the capacity to thrive amidst disruptions, offering insights into how systems respond to shocks and stresses over time. Holling (1973), the foundational figure in resilience theory, introduced the concept in the context of ecological systems, distinguishing resilience from stability. Stability refers to a system's ability to return to equilibrium after a disturbance, while resilience focuses on the capacity of systems to absorb disturbances and adapt to new conditions without collapsing. Holling's work highlights that resilient systems do not merely return to their original state but adapt to changing circumstances, maintaining their core functions and integrity, which can help understand climate change adaptation. This adaptive capacity is particularly vital in environments characterized by uncertainty and rapid change, such as ecosystems facing climate change or human systems experiencing social and economic disruption.

This theory can be applied beyond ecology, into complicated organizational and social systems. A study by Carlson et al. (2012) emphasizes that resilience is not merely about surviving disruptions but also about learning from them to build stronger, more adaptive systems. This perspective is critical for modern challenges posed by climate change. Greene et al. (2004) conceptualize resilience as the capacity to bounce back from adversity, such as trauma or economic hardship, by leveraging protective factors, such as strong social networks, supportive

policies, and individual coping mechanisms. The paper showcases how resilience is influenced by both internal factors, like psychological strength, and external factors, like community support systems. This view of resilience as a dynamic and process-oriented phenomenon, shaped by interactions between individuals and their environments, can help understand the link between digital inclusion and locally-led adaptation.

Resilience theory provides a valuable lens for understanding the relationship between digital inclusion and the capacity of individuals and communities to adapt and thrive in the face of disruptions and inequalities. For example, Roberts et al. (2017) suggest that digital inclusion can enhance rural communities' adaptive capacities by fostering greater social cohesion and economic diversification. They showcase that resilience in this context requires a holistic approach that integrates digital access with broader community development efforts, ensuring that rural areas can leverage digital technologies to address their unique challenges. Leurs (2022) argues that, from a resilience perspective, digital inclusion initiatives must not only provide access but also build adaptive capacities that enable vulnerable populations to leverage digital tools effectively and sustainably, thus enhancing their resilience to shocks and systemic barriers. Roberts et al. (2015) propose a framework for evaluating digital technologies through the lens of resilience, underscoring the idea that resilience and digital inclusion are mutually reinforcing: resilient communities are better equipped to adopt and benefit from digital technologies, while inclusive digital technologies can enhance resilience by expanding access to resources and opportunities. Overall, resilience emphasizes adaptability, resourcefulness, and the ability to maintain functionality amidst challenges, principles that resonate strongly with the goals of digital inclusion and have the potential to support locally-led climate change adaptation.

Methodology

Research Design

This research paper utilizes a qualitative research design with an abductive approach. Qualitative research is a methodological approach that can help with understanding phenomena in a naturalistic setting, exploring people's lived experiences, perspectives, and meanings. Unlike quantitative research, which seeks to measure variables and often identify causal relationships, qualitative research aims to gain a deeper, more nuanced understanding of social phenomena

(Creswell & Poth, 2016). It typically allows for the production of “rich” and descriptive data, which can be particularly useful for exploring less-explored research areas or unexplained phenomena. Qualitative research is particularly appropriate for this study, which aims to explore how digital inclusion initiatives, such as UDCs, can contribute to locally-led climate change adaptation. This allows for a deeper exploration of individual experiences, providing insights into how UDC entrepreneurs and users navigate digital inclusion efforts. Moreover, this approach allows for the exploration of participants' experiences, perceptions, and meanings, providing insights into how UDCs can impact local climate adaptation efforts and how digital inclusion can shape these processes.

This research utilizes an abductive approach, which is distinct from the inductive or deductive approaches. The abductive approach focuses on generating new insights or explanations by combining existing knowledge and data to explore the most plausible explanations for observed phenomena (Timmermans & Tavory, 2012). In this study, the abductive approach was chosen because it allows for flexibility in examining the complex relationship between digital inclusion and climate adaptation, especially in the context of UDCs in Bangladesh. By combining existing theories with the data collected through interviews, this approach helps to identify new patterns, construct a conceptual framework, and address the research questions with a fresh perspective. It is particularly appropriate when the aim is to explore phenomena that are not yet fully understood or where new conceptual connections need to be formed, which is precisely the case here. The abductive approach thus provides the necessary flexibility to develop insights into how digital inclusion initiatives can contribute to locally-led climate adaptation efforts.

The specific qualitative method used here is the case study method, which is a qualitative research strategy that involves an in-depth, contextually rich examination of a specific instance or case (Creswell & Poth, 2016). In this study, UDCs are the case being investigated. UDCs, as a locally-rooted digital inclusion initiative, serve as an ideal case for exploring the intersection of technology and climate adaptation at the community level. This approach allows for a detailed investigation of how UDCs function, the challenges they face, and their potential for contributing to locally-led adaptation strategies. Using a case study method also allows the researcher to analyze the particularities of UDCs in their context, making it easier to understand the specific mechanisms through which digital inclusion initiatives like UDCs can foster resilience and support locally-led responses to climate change.

Data Collection and Analysis

For developing the case, the study collected primary sources of data with in-depth interviews (IDIs) and participant observations. Three unions were chosen to collect the data from, which are Manikchari Sadar Union from Khagrachari district, Tintohori Union from Khagrachari district, and Madhukhali Union from Faridpur district. These UDCs were chosen based on convenient sampling, considering the challenges of access and travel. All of these unions have moderate levels of climate vulnerability according to the UNDP Climate Vulnerability Index and face diverse climate risks.

IDIs with open-ended questionnaires were used as the primary data collection method. This was chosen since it allows for a strong focus on the particular research questions while being open to the different perspectives, issues, and opinions of participants (Lichtman, 2013). Interviews were conducted with a total of 13 respondents, including 3 UDC entrepreneurs and 10 service recipients. One UDC entrepreneur was interviewed from each of the three unions. For the service recipients, potential respondents were approached after they availed of the services of the UDC. While this allowed for insights from authentic service users, this also led to a low number of respondents since many of them were not willing to participate. However, since this is an exploratory study, this should still allow for valuable information even if it is not highly generalizable.

Type of Interviewee	Number of Interviewees
Climate-vulnerable Service Recipients	10
UDC entrepreneurs	3
Total	**13**

Table 1: Interview Respondents

The study also collected data using unstructured, participant observations. As a data collection method, observations often involve systematically watching and recording behaviors, events, or phenomena in their natural setting. This method is often used in qualitative research to gain a deeper understanding of a particular situation or context by capturing real-world dynamics and interactions (Lofland et al., 2022). In each of the three unions, data was collected on the physical and social environment in which UDCs operate, how people interact within UDCs, how people engage with others, any relevant social dynamics or barriers, and non-verbal social cues. Observations were very useful for this study as they provided rich, contextual insights into how

UDCs operate in practice, how local communities interact with these centers, and how they contribute to climate adaptation efforts. Moreover, observations can play a complementary role to the data collected through interviews. By combining insights from both of these methods, a more holistic understanding of the role of digital inclusion in supporting locally-led adaptation can be gained. As for the data analysis, a thematic analysis approach was used to understand the patterns in the data and structure them into relevant themes.

Findings

Theme 1: UDCs as Information Hubs

UDCs play a pivotal role as community-level information hubs, addressing citizens' needs for service access and disseminating knowledge. Beyond providing access to crucial digital services, they also help connect citizens with not only digital services but also other offline services. A claim by the entrepreneurs is that “people mostly go to Union Parishad members and chairpersons when they have questions. But they don’t always know all the details and so they send people to us.” This highlights UDCs' role as trusted resources when formal institutions fail to provide clear information. Moreover, UDCs serve as critical intermediaries for clarifying procedural and bureaucratic complexities. Additionally, UDCs use innovative information dissemination methods, such as broadcasting via loudspeakers and operating social media pages to educate people on accessing various services. Their reach underscores their embeddedness in the community as trusted access points. Moreover, UDCs facilitate workshops to disseminate crucial information, educating citizens about social safety net programs and services offered by specific government offices (e.g., agriculture and women development).

However, major gaps remain in its role as an information hub. The lack of electricity in remote areas and unreliable servers of government office websites remain significant barriers to seamless service delivery. Moreover, environmental or climate-related information is conspicuously absent. Entrepreneurs acknowledge that UDCs “can disseminate information and spread awareness about climate change,” but no such initiatives have been implemented yet. While this gap shows the current ineffectiveness of UDCs in supporting locally-led adaptation, its position as a potential information hub also highlights the potential for assisting adaptation efforts.

Theme 2: Supporting Capacity Development of Local Citizens

The primary function of the UDC is to provide services, which include facilitating birth registration, national identity card applications, online job applications, holding tax services, agent banking, etc. These crucial services can help citizens take steps towards developing their capacity and improving themselves. Moreover, it was observed that many of the service recipients were women, who are often marginalized and struggle to attain services. Beyond offering essential services, UDCs actively contribute to capacity-building initiatives aimed at empowering citizens. This includes organizing workshops to demystify government services and offering specialized training. For example, one of the UDCs had previously rented a shop to provide computer literacy training but stopped due to financial constraints. These UDCs also conduct other workshops focusing on educating people about accessing social safety nets like the Vulnerable Group Development (VGD) program. As entrepreneurs noted, “Different officers (agriculture, women development) come to these seminars and tell people about their respective areas.” This collaboration helps enhance community awareness of government functions and improves service uptake. By assisting the target population access the services and benefits they need, UDCs indirectly contribute to their capacity development.

However, these efforts are not without limitations. For instance, despite attempts to bridge knowledge gaps, many citizens still lack a fundamental understanding of bureaucratic processes. One significant challenge involves ensuring documentation accuracy, as “people sometimes provide false or incomplete information,” leading to delays or service denials. In climate-related contexts, UDCs recognize an untapped potential for education and awareness. Entrepreneurs expressed a willingness to integrate climate adaptation knowledge into their training sessions, provided they received the requisite training and resources. They propose presenting videos or workshops to inform citizens about eco-friendly practices and locally relevant adaptation strategies. Although financial constraints, among others, limit their capacity to sustain training and other capacity-building initiatives for supporting locally-led adaptation efforts, UDCs demonstrate their commitment to fostering local empowerment through consistent service improvements and highlight the potential for supporting LLA.

Theme 3: Collaboration with Different Organizations

UDCs hold significant potential for collaboration with non-profits, government agencies, and local authorities, which could amplify their impact on community resilience and adaptation efforts.

Current collaborations are limited, often involving entrepreneurs attending NGO-organized seminars rather than direct joint initiatives. One entrepreneur mentioned the potential to collaborate with organizations like Red Crescent, who already work in those unions, to provide services. They also highlighted challenges such that local non-profits “don’t have sufficient manpower and long-term follow-up capabilities,” suggesting that UDCs could address this gap. Entrepreneurs proposed facilitating follow-up activities after NGO programs to ensure the sustainability of interventions. Similarly, UDCs already collaborate with government departments like Social Welfare and Agriculture to organize workshops and disseminate service-related information. However, collaboration and coordination with government agencies suffer from severe challenges. For example, government departments do not always provide them with the up-to-date information that they need. Moreover, dealing with the lengthy and burdensome process of government chains of command stifles opportunities for fruitful collaboration with government agencies.

Despite the potential for collaboration, challenges persist. Logistical issues such as poor infrastructure and security threats in remote areas further hinder collaborations. Additionally, entrepreneurs lack formal training on climate adaptation, restricting their ability to facilitate such initiatives. They suggested convening meetings with respected community leaders to raise awareness about climate change and encourage localized adaptation strategies. These challenges and gaps highlight the potential that collaborations could help strengthen ties between stakeholders, enabling more robust and inclusive support for locally-led adaptation. While UDCs are poised to bridge gaps between organizations and communities, realizing this potential will require enhanced training, institutional support, and investment in infrastructure.

Theme 4: Knowledge Gaps in Climate Change and Adaptation

Despite their role as information hubs, UDCs have yet to integrate climate change and adaptation education into their outreach. Citizens' awareness of climate issues remains limited, as nobody in the unions being studied has asked about information related to climate change. As one service taker remarked, “We haven’t really felt the effects of climate change here. If we learn more about it, we can do something to help ourselves.” Entrepreneurs echoed this sentiment, emphasizing that awareness is the first step toward enabling locally led adaptation. They proposed using workshops and visual materials to educate citizens about climate risks and eco-friendly practices. However, they highlighted the need for their own training to effectively convey this information.

UDCs' current environmental involvement is minimal. Although some service takers associate UDCs with relief distribution during natural disasters, this is primarily a government initiative channeled through UDCs. More proactive roles, such as disseminating climate-related information or fostering sustainable practices, have yet to be realized. These gaps underscore a significant opportunity for UDCs to address knowledge gaps and contribute to supporting locally-led adaptation efforts. However, realizing this potential requires strategic investment in training and resource allocation.

Theme 5: Capacity Building and Resource Needs for UDC Entrepreneurs

For UDCs to fulfill their potential, entrepreneurs must be equipped with the necessary training, financial stability, and resources. Entrepreneurs identified training on climate change and locally led adaptation as a critical need. As one entrepreneur stated, “We need to know how to explain climate change to people, what they can do to adapt, and how to guide them through these challenges.” Financial sustainability is another pressing concern. Entrepreneurs currently rely on income from service fees, which is often unstable. They feel as though they do not earn enough money to support their family, which can be a huge challenge when talking about potentially taking on even greater responsibilities. They suggested introducing salaries for climate-related work to provide financial security and incentivize their involvement in adaptation efforts. Resource constraints, such as unreliable digital infrastructure and limited access to training materials, further exacerbate these challenges. Security issues in remote areas also pose operational risks. Despite these barriers, entrepreneurs seem to remain committed to their role as community facilitators. With adequate support, they believe UDCs could significantly enhance their contribution to locally-led climate adaptation and broader community development.

Discussion

Role of Digital Inclusion in Supporting Locally-led Adaptation

From the case of UDCs, we can discern both the challenges and opportunities that digital inclusion initiatives present in supporting locally-led adaptation. The role digital inclusion initiatives can play

in supporting adaptation becomes evident when mapped to the eight principles outlined by Soanes et al. (2021).

First, devolving decision-making to the community level is critical for empowering local citizens. Digital inclusion initiatives like UDCs provide platforms for community engagement with government services and adaptation resources. By decentralizing information dissemination, UDCs enable citizens to make informed decisions about adaptation strategies. For example, workshops and social media initiatives can help farmers adopt climate-resilient agricultural practices. Drawing on Sen's Capability Theory, this approach enhances individuals' capabilities by expanding their access to knowledge and resources, empowering them to act on decisions that matter to their well-being and survival. However, for these initiatives to reach their full potential, enhanced resources, and decision-making authority are essential to tailor services to local adaptation needs.

Second, digital inclusion initiatives address structural inequalities, particularly among marginalized groups like women and remote populations who are disproportionately affected by climate change. UDCs bridge these gaps by offering tailored workshops, digital literacy training, and assistance with social safety nets. For instance, women-focused workshops could teach eco-friendly livelihood strategies or disaster preparedness. Resilience Theory underscores the importance of reducing vulnerabilities to shocks by ensuring that these structurally marginalized groups have equitable access to adaptation support. To maximize impact, digital inclusion initiatives must proactively target underserved areas and tackle systemic barriers, such as infrastructure deficits and security issues, that hinder inclusivity.

Third, accessible funding remains a major challenge for local citizens needing resources for sustainable practices or recovery from climate-related impacts. UDCs can play a transformative role by connecting citizens to government grants, subsidies, and NGO funding opportunities. By streamlining bureaucratic processes and offering guidance on application requirements, UDCs help citizens access adaptation funding more effectively. Additionally, introducing microfinance initiatives through UDCs could provide low-interest loans for community-led adaptation projects, expanding economic opportunities to enable individuals to lead adaptive and fulfilling lives, which is a core idea in Sen's capability theory.

Investing in local capabilities is foundational to adaptation. UDCs already contribute to building citizens' capacity through training programs on topics like disaster preparedness, water management, and sustainable agriculture. For instance, they could teach farmers to adapt to erratic rainfall patterns with climate-smart techniques. Expanding these initiatives to include

climate-specific education would empower citizens to take ownership of their adaptation processes. Both Capability and Resilience Theories highlight that fostering knowledge and skills enhances adaptive capacity, enabling communities to anticipate, absorb, and recover from climate shocks more effectively.

Despite their role as information hubs, many citizens lack awareness of climate risks and their potential impacts. UDCs can bridge this gap by disseminating localized climate information through workshops, community meetings, and digital platforms. For example, practical advice on flood preparedness or water conservation during droughts could significantly enhance community resilience. Entrepreneurs' interest in using visual aids and storytelling aligns with Resilience Theory's emphasis on fostering adaptive learning and innovation to address complex challenges.

Flexible programming allows UDCs to align their services with the evolving needs of local communities. During extreme weather events, UDCs can shift their focus to relief coordination and post-disaster recovery efforts. Seasonal challenges, such as preparing for monsoons or addressing water scarcity, can also shape their programming. This adaptability strengthens community resilience by enabling timely responses to climate shocks. However, sustaining such flexibility requires stable funding and responsive governance structures.

Citizens often struggle to hold government institutions accountable for adaptation-related shortcomings. UDCs can enhance accountability by acting as intermediaries, ensuring adaptation resources reach intended beneficiaries. For example, UDCs could monitor relief fund distribution or oversee local adaptation project implementation. By fostering a culture of accountability, these initiatives empower citizens to demand equitable and effective support, aligning with Sen's emphasis on creating institutional mechanisms that expand freedoms and address injustices.

Finally, UDCs can facilitate collaborative action by acting as bridges between local communities, NGOs, government agencies, and private sector actors. For instance, they could host joint workshops where citizens learn about government adaptation programs while NGOs provide technical guidance. UDCs could also coordinate with local leaders to design and implement community-driven adaptation strategies. Resilience Theory emphasizes the need for multi-stakeholder collaboration to strengthen system-wide capacities for managing uncertainty and risk. By fostering such partnerships, digital inclusion initiatives ensure that adaptation efforts are inclusive, participatory, and aligned with local priorities.

Recommendations

Based on the results and discussions of this paper, the following are some recommendations for allowing digital inclusion initiatives to better support locally-led adaptation:

1. Provide specialized training for UDC entrepreneurs on climate change, locally-led adaptation (LLA), and climate-resilient practices. This will empower them to deliver relevant information and guidance to local citizens and ensure that adaptation strategies are integrated into community-level services.
2. Create platforms or workshops at UDCs to disseminate localized climate risk information, such as flood forecasts, drought preparedness, and sustainable farming techniques. This will fill the current knowledge gap in climate change awareness and enable local communities to take proactive steps in their adaptation efforts.
3. Invest in improving digital and physical infrastructure in underserved areas, especially in locations with electricity deficits or security concerns. This ensures that UDCs can reach more people and provide continuous service, including climate adaptation resources.
4. Facilitate stronger, more structured partnerships with government agencies and NGOs that focus on climate adaptation. This could involve sharing resources, and knowledge, and coordinating efforts to ensure that climate adaptation programs are locally relevant and accessible.
5. Establish mechanisms within UDCs that provide local citizens with access to climate adaptation funding, including government subsidies and microfinance for sustainable practices. This could include simplifying application processes and offering support to navigate the bureaucracy.
6. Empower UDCs to act as accountability hubs by monitoring the distribution of climate adaptation resources, ensuring that they reach the intended beneficiaries, and addressing gaps in implementation.
7. Build flexibility into UDC services to allow quick responses to seasonal and weather-related changes. This could include adjusting workshops or services based on immediate climate risks, such as preparing for the monsoon season or providing emergency disaster response information during floods.
8. Ensure that local knowledge and practices are integrated into the adaptation strategies promoted by UDCs. Community leaders and respected figures should be engaged to tailor climate adaptation programs to local contexts, fostering trust and greater community buy-in.

9. Explore funding models that ensure the long-term sustainability of UDCs and their adaptation-related services. This could include introducing stable government funding or establishing income-generating activities that allow UDCs to continue their support of climate adaptation without financial instability.
10. Pay special attention to marginalized populations, such as women and ethnic minorities, by providing targeted workshops and support. This could involve training on eco-friendly livelihoods, and disaster resilience, and enabling these groups to play a central role in adaptation efforts.

Conclusion

The findings illustrate the potential of digital inclusion initiatives, exemplified by UDCs, to support locally-led adaptation by expanding citizens' capabilities, addressing inequalities, and fostering resilience. By directly supporting local people with knowledge, resources, and collaborative opportunities, these initiatives can empower communities to take ownership of their adaptation. UDCs can empower local communities by acting as accessible hubs for information and services, fostering greater autonomy. However, gaps in resources, training, and decision-making authority limit UDCs' ability to fully support local adaptation needs. A significant challenge is the lack of climate change knowledge among citizens, which UDCs could address through targeted education, provided they receive the necessary tools and training. Infrastructure issues, such as unreliable electricity and digital connectivity, hinder the effectiveness of UDCs, particularly in remote areas, emphasizing the need for improved infrastructure to ensure equal access to adaptation resources.

Despite their achievements, significant opportunities remain untapped, particularly in integrating climate change education and fostering collaboration with organizations. UDCs' potential to support locally-led adaptation efforts hinges on addressing resource constraints, improving infrastructure, and equipping entrepreneurs with the necessary training and financial stability to expand their roles effectively. Realizing this potential requires strategic investments in capacity building, infrastructure, and institutional support. These initiatives must not only address immediate challenges but also build long-term adaptive capacities, ensuring that communities are resilient in the face of climate change. By shedding light on the current scenario and challenges faced by UDCs in facilitating locally-led adaptation, the study offers insights that can inform

strategic adjustments, ultimately contributing to more effective digital inclusion initiatives and locally-led adaptation outcomes.

Limitations and Scope for Further Study

This research paper, while providing important insights into the intersection of digital inclusion initiatives and locally-led adaptation, does have several limitations that should be acknowledged. First, the study chooses to take UDCs as a case study for digital inclusion initiatives in general. However, the findings supported by UDCs might not be completely generalizable to all kinds of digital inclusion initiatives in different contexts. Moreover, the scope of the paper is limited to a small sample of UDCs in specific rural areas. This narrow geographical focus may not fully represent the diverse contexts and challenges faced by UDCs in other regions, particularly those with much more severe climate change impacts. Secondly, the research primarily relies on qualitative data from interviews with UDC entrepreneurs and service takers. While this provides rich, context-specific insights, it may introduce subjectivity or bias. For instance, the entrepreneurs' perspectives could be influenced by their vested interest in the success and recognition of UDCs, potentially overemphasizing the positives and underreporting the challenges. Additionally, service takers may have limited awareness of the broader scope of climate adaptation efforts, which could affect the depth of their responses regarding climate-related issues.

Another limitation lies in the absence of a comprehensive longitudinal approach. The research captures a snapshot of current practices but does not explore the long-term impact of UDCs on community adaptation over time. As climate change adaptation is a prolonged process, a longitudinal study would offer more insight into the sustainability and effectiveness of digital inclusion initiatives in supporting locally-led adaptation. Finally, while the study touches on the potential of collaborations with NGOs and government agencies, it does not delve deeply into the structural or institutional barriers that hinder such partnerships, such as the bureaucratic red tape or coordination challenges that often emerge in real-world implementation. However, this is an exploratory study into an otherwise unexplored intersection of research and the role of the paper is to support further research in this area. As a result, many of the ideas proposed throughout this paper can be further tested empirically through different methods. Moreover, establishing causal factors through experiments could be beneficial for improving our understanding of how digital inclusion is linked with climate change adaptation.

References

Abedin, M. M., Ferdaus, M., Shah, A. M. M. M., & Sayem, M. A. (2021). The Role of Union Digital Centres in Reducing Social Inequalities in Bangladesh. *Bangladesh Journal of Public Administration*, *29*(3), Article 3. https://doi.org/10.36609/bjpa.v29i3.100

Akter, M., & Husain, T. (2021). The Impact of Union Digital Centre on Women Empowerment: An Assessment on Rural Areas of Bangladesh. *Dynamics of Public Administration*, *38*, 188–197. https://doi.org/10.5958/0976-0733.2021.00014.6

Alhassan, M. D., & Adam, I. O. (2024). Digital inclusion and sustainable development goals. *Journal of Science and Technology Policy Management*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/JSTPM-09-2023-0152

Alkire, S. (2005). Why the Capability Approach? *Journal of Human Development*, *6*(1), 115–135. https://doi.org/10.1080/146498805200034275

Ayers, J. (2010). *Understanding the adaptation paradox: Can global climate change adaptation policy be locally inclusive?* [PhD Thesis, London School of Economics and Political Science]. https://etheses.lse.ac.uk/393/

Beauchamp, E., Sainsbury, N. C., Greene, S., & Chaigneau, T. (2021). Aligning Resilience and Wellbeing Outcomes for Locally-Led Adaptation in Tanzania. *Sustainability*, *13*(16), Article 16. https://doi.org/10.3390/su13168976

Bedelian, C., Mulwa, J., Sumari, B., Rogers, P., Ladekjær Gravesen, M., & Funder, M. (2024). *Locally-led adaptation: Moving from principles to practice in the water sector*. DIIS, Danish Institute for International Studies.

Biswas, B., & Roy, S. K. (2020). Service quality, satisfaction and intention to use Union Digital Center in Bangladesh: The moderating effect of citizen participation. *PLOS ONE*, *15*(12), e0244609. https://doi.org/10.1371/journal.pone.0244609

Carlson, J. L., Haffenden, R. A., Bassett, G. W., Buehring, W. A., Collins, I. I. I., Folga, S. M., Petit, F. D., Phillips, J. A., Verner, D. R., & Whitfield, R. G. (2012). *Resilience: Theory and Application.* (ANL/DIS-12-1). Argonne National Lab. (ANL), Argonne, IL (United States). https://doi.org/10.2172/1044521

Celestino, M. S., & Valente, V. C. P. N. (2022). The digital exclusion and the commitment to the sustainable development Goals in Brazil. *International Journal of Development Research*, *12*(3), 54961–54967. https://doi.org/10.37118/ijdr.24232.3.2022

Charleson, D. (2012). Bridging the digital divide: Enhancing empowerment and social capital. *Journal of Social Inclusion*, *3*(2). https://doi.org/10.36251/josi52

Clayton, J., Macdonald, S. J., Smith, P., & Wilcock, A. (2015). The Impact of Digital Inclusion Initiatives in a Civic Context. In *Encyclopedia of Information Science and Technology, Third Edition* (pp. 6863–6873). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-4666-5888-2.ch676

Coger, T., Corry, S., & Gregorowski, R. (2021). *Reshaping Monitoring, Evaluation and Learning for Locally Led Adaptation*. World Resources Institute. https://doi.org/10.46830/wriwp.20.00060

Coger, T., Dinshaw, A., Tye, S., Kratzer, B., Thazin Aung, M., Cunningham, E., Ramkissoon, C., Gupta, S., Bodrud-Doza, Md., Karamallis, A., Mbewe, S., Granderson, A., Dolcemascolo, G., Tewary, A., Mirza, A., & Carthy, A. (2022). *Locally Led Adaptation: From Principles to Practice*. World Resources Institute. https://doi.org/10.46830/wriwp.21.00142

Comim, F., Qizilbash, M., & Alkire, S. (2008). *The Capability Approach: Concepts, Measures and Applications*. Cambridge University Press.

Cooper, L. (2023, August 21). How the Digital Divide Worsens the Human Impacts of Climate Change. *Human-I-T*. https://www.human-i-t.org/digital-divide-climate-change/

Correa, T., & Pavez, I. (2016). Digital Inclusion in Rural Areas: A Qualitative Exploration of Challenges Faced by People From Isolated Communities. *Journal of Computer-Mediated Communication*, *21*(3), 247–263. https://doi.org/10.1111/jcc4.12154

Creswell, J. W., & Poth, C. N. (2016). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. SAGE Publications.

Dinshaw, A., McGinn, C., Mamoudou Boubacar, M., J.B. Keregero, K., A. Mojaki, R., Illiassou Salamatou, A., & Sann, K. (2023). *Untapped Potential: The Role of Local Governments in Locally Led Adaptation. Experiences from the Local Climate Adaptive Living Facility (LoCAL) in Niger, Lesotho, and Cambodia*. World Resources Institute. https://doi.org/10.46830/wriwp.22.00044

Dwivedi, Y. K., Hughes, L., Kar, A. K., Baabdullah, A. M., Grover, P., Abbas, R., Andreini, D., Abumoghli, I., Barlette, Y., Bunker, D., Chandra Kruse, L., Constantiou, I., Davison, R. M., De', R., Dubey, R., Fenby-Taylor, H., Gupta, B., He, W., Kodama, M., … Wade, M. (2022). Climate

change and COP26: Are digital technologies and information management part of the problem or the solution? An editorial reflection and call to action. *International Journal of Information Management*, *63*, 102456. https://doi.org/10.1016/j.ijinfomgt.2021.102456

Eakin, H., Wightman, P. M., Hsu, D., Gil Ramón, V. R., Fuentes-Contreras, E., Cox, M. P., Hyman, T.-A. N., Pacas, C., Borraz, F., González-Brambila, C., Ponce De León Barido, D., & Kammen, D. M. (2015). Information and communication technologies and climate change adaptation in Latin America and the Caribbean: A framework for action. *Climate and Development*, *7*(3), 208–222. https://doi.org/10.1080/17565529.2014.951021

Eichberger, J., & Guerdjikova, A. (2012). Technology Adoption and Adaptation to Climate Change—A Case-Based Approach. *Climate Change Economics*, *3*(2), 1–41.

Faroqi, G. (2015). Financial sustainability of union digital center in Bangladesh. *The Journal of Developing Areas*, *49*(6), 61–73. https://doi.org/10.1353/jda.2015.0096

Fisk, R. P., Gallan, A. S., Joubert, A. M., Beekhuyzen, J., Cheung, L., & Russell-Bennett, R. (2023). Healing the Digital Divide With Digital Inclusion: Enabling Human Capabilities. *Journal of Service Research*, *26*(4), 542–559. https://doi.org/10.1177/10946705221140148

Frediani, A. A. (2010). Sen's Capability Approach as a framework to the practice of development. *Development in Practice*, *20*(2), 173–187. https://doi.org/10.1080/09614520903564181

Gain, A. K., & Fritsch, O. (2024). Bridging the digital divide for effective environmental management. *Australasian Journal of Environmental Management*, *31*(2), 129–135. https://doi.org/10.1080/14486563.2024.2373629

Global Center on Adaptation. (2019). *Adapt now: A global call for leadership on climate resilience*. Global Center on Adaptation and World Resources Institute. https://gca.org/reports/adapt-now-a-global-call-for-leadership-on-climate-resilience/

Greene, R. R., Galambos, C., & Lee, Y. (2004). Resilience Theory: Theoretical and Professional Conceptualizations. *Journal of Human Behavior in the Social Environment*, *8*(4), 75–91. https://doi.org/10.1300/J137v08n04_05

Grossi, A., & Dinku, T. (2022). Enhancing national climate services: How systems thinking can accelerate locally led adaptation. *One Earth*, *5*(1), 74–83. https://doi.org/10.1016/j.oneear.2021.12.007

Hagerty, C. (2023, June 20). How climate vulnerability and the digital divide are linked. *MIT Technology Review*. https://www.technologyreview.com/2023/06/20/1074244/climate-vulnerability-digital-divide/

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, *4*, 1–23.

Hoque, M. R. (2020). The impact of the ICT4D project on sustainable rural development using a capability approach: Evidence from Bangladesh. *Technology in Society*, *61*, 101254. https://doi.org/10.1016/j.techsoc.2020.101254

Hoque, Md. R., Sorwar, G., & Hossain, Md. U. (2022). *Sustainable Rural Development through Union Digital Center: The Citizen Empowerment Perspective*. Hawaii International Conference on System Sciences. https://doi.org/10.24251/HICSS.2022.339

Hoque, S. M. S. (2020). Government Information and Service Delivery Through Union Digital Centers in Bangladesh: Users' Perceptions on Good Governance. *International Journal of Electronic Government Research*, *16*(3), 45–64. https://doi.org/10.4018/IJEGR.2020070103

Hosen, M. M., Nur, S., & Khatun, M. N. (2022). Role of Union Digital Centre (UDC) to Empower Rural People: A Case Study on Pabna Sadar Upazila, Bangladesh. *South Asian Journal of Social Sciences and Humanities*, *3*(5), Article 5. https://doi.org/10.48165/sajssh.2022.3506

Hossen, M. B. (2024, October 7). Why Union Digital Centres have fallen from grace. *The Business Standard*. https://www.tbsnews.net/bangladesh/why-union-digital-centres-have-fallen-grace-960076

Islam, M. A., & Islam, M. N. (2018). Exploring the shortcomings of Union Digital Center (UDC) in Bangladesh: A Study. *Indian Journal of Library and Information Science*, *12*(2), 95–100. https://doi.org/10.21088/ijlis.0973.9548.12218.4

Jahan, A. R. T. (2023, December 3). Union Digital Centers: Digitizing Bangladesh's Grassroots. *The Confluence*. https://theconfluence.blog/union-digital-centers-digitizing-bangladeshs-grassroots/

Larroquette, B., & Otsuka, R. (2021, May 10). Bridging the Digital Divide Will Save Our Planet. *Inter Press Service*. https://www.ipsnews.net/2021/05/bridging-digital-divide-will-save-planet/

Leurs, K. (2022). Resilience and Digital Inclusion: The Digital Re-making of Vulnerability? In P. Tsatsou (Ed.), *Vulnerable People and Digital Inclusion: Theoretical and Applied Perspectives* (pp. 27–46). Springer International Publishing. https://doi.org/10.1007/978-3-030-94122-2_2

Lichtman, M. (2013). *Qualitative Research for the Social Sciences*. SAGE Publications.

Lofland, J., Snow, D., Anderson, L., & Lofland, L. H. (2022). *Analyzing Social Settings: A Guide to Qualitative Observation and Analysis, Fourth Edition*. Waveland Press.

Madon, S., Reinhard, N., Roode, D., & Walsham, G. (2009). Digital inclusion projects in developing countries: Processes of institutionalization. *Information Technology for Development*, *15*(2), 95–107. https://doi.org/10.1002/itdj.20108

Mamun, M. A., & Begum, M. U. A. (2018). Sustainability Of Union Digital Centre In Bangladesh: Has It Got Institutional Roots? *European Journal of Social Sciences Studies*, *3*(2), Article 0. https://doi.org/10.46827/ejsss.v0i0.425

Molina, A. (2003). The Digital Divide: The Need for a Global e-Inclusion Movement. *Technology Analysis & Strategic Management*, *15*(1), 137–152. https://doi.org/10.1080/0953732032000046105

Mondal, T., Islam, M. S., Islam, M. R., Abdullah, M. M., Monalesa, N., & Das, D. (2023). A Study on the Effectiveness of Utilization of the Union Digital Center Agricultural Information by the Farmers in Bangladesh. *Asian Journal of Agricultural Extension, Economics & Sociology*, *41*(9), Article 9. https://doi.org/10.9734/ajaees/2023/v41i92130

Nemer, D. (2015). From Digital Divide to Digital Inclusion and Beyond. *The Journal of Community Informatics*, *11*(1), Article 1. https://doi.org/10.15353/joci.v11i1.2857

Pachauri, R. K., Allen, M. R., Barros, V. R., Broome, J., Cramer, W., Christ, R., Church, J. A., Clarke, L., Dahe, Q., Dasgupta, P., Dubash, N. K., Edenhofer, O., Elgizouli, I., Field, C. B., Forster, P., Friedlingstein, P., Fuglestvedt, J., Gomez-Echeverri, L., Hallegatte, S., … van Ypserle, J.-P. (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. In R. K. Pachauri & L. Meyer (Eds.), *EPIC3Geneva, Switzerland, IPCC, 151 p., pp. 151, ISBN: 978-92-9169-143-2* (p. 151). IPCC. https://epic.awi.de/id/eprint/37530/

Park, S. (2017). Digital inequalities in rural Australia: A double jeopardy of remoteness and social exclusion. *Journal of Rural Studies*, *54*, 399–407. https://doi.org/10.1016/j.jrurstud.2015.12.018

Poveda, S. C. (2016). How can digital inclusion promote social change? Exploring two Brazilian case studies. *Proceedings of the Eighth International Conference on Information and Communication Technologies and Development*, 1–11. https://doi.org/10.1145/2909609.2909672

Ragnedda, M., & Mutsvairo, B. (Eds.) (with Goggin, G., Abdollahyan, H., Ansari, M. S., Ben-Harush, O., Chen, A., Dalvit, L., Hammond, C., & Jin, J.). (2018). *Digital Inclusion: An International Comparative Analysis*. Lexington Books. https://doi.org/10.5771/9781498562133

Rahman, M. F., Falzon, D., Robinson, S., Kuhl, L., Westoby, R., Omukuti, J., Schipper, E. L. F., McNamara, K. E., Resurrección, B. P., Mfitumukiza, D., & Nadiruzzaman, Md. (2023). Locally led adaptation: Promise, pitfalls, and possibilities. *Ambio*, *52*(10), 1543–1557. https://doi.org/10.1007/s13280-023-01884-7

Rahman, M., Islam, M., & Ali, M. (2020). Exploring the Role of Union Digital Center to Managing Information Services in Rural Development of Bangladesh. *Bangladesh Journal of Public Administration (BJPA)*, *28*(2), 2664–4622. https://doi.org/10.36609/bjpa.v28i2.107

Rahman, S. M. A. (2016). Prospects of PPP in Expanding ICT Services in Rural Bangladesh: A Case of Union Digital Center. *International Journal of Economics and Finance*, *8*(2), 163–170. https://doi.org/10.5539/ijef.v8n2p163

Rao, S. S. (2005). Bridging digital divide: Efforts in India. *Telematics and Informatics*, *22*(4), 361–375. https://doi.org/10.1016/j.tele.2005.01.007

Roberts, E., Beel, D., Philip, L., & Townsend, L. (2017). Rural resilience in a digital society: Editorial. *Journal of Rural Studies*, *54*, 355–359. https://doi.org/10.1016/j.jrurstud.2017.06.010

Roberts, E., Farrington, J., & Skerratt, S. (2015). Evaluating New Digital Technologies Through a Framework of Resilience. *Scottish Geographical Journal*, *131*(3–4), 253–264. https://doi.org/10.1080/14702541.2015.1068947

Robeyns, I. (2005). The Capability Approach: A theoretical survey. *Journal of Human Development*, *6*(1), 93–117. https://doi.org/10.1080/146498805200034266

Roome, J. (2016, January 14). The Digital Divide: A challenge to overcome in tackling climate change. *World Bank Blogs*. https://blogs.worldbank.org/en/climatechange/digital-divide-challenge-overcome-tackling-climate-change

Soanes, M., Bahadur, A., Shakya, C., Smith, B., Patel, S., Coger, T., Dinshaw, A., Patel, S., Huq, S., Musa, M., Rahman, F., Gupta, S., Dolcemascolo, G., & Mann, T. (2021). *Principles for locally led adaptation*. IIED.

Timmermans, S., & Tavory, I. (2012). Theory Construction in Qualitative Research: From Grounded Theory to Abductive Analysis. *Sociological Theory*, *30*(3), 167–186. https://doi.org/10.1177/0735275112457914

Tshivhase, M., Turpin, M., & Matthee, M. (2016). The use of Sen's capability approach in ICT4D: An exploratory review. *CONF-IRM 2016 Proceedings*. https://aisel.aisnet.org/confirm2016/10

Vincent, K. (2023). Development geography II: Community-based adaptation and locally-led adaptation. *Progress in Human Geography*, *47*(4), 604–612. https://doi.org/10.1177/03091325231166076

Waughen, K. (2015). The Digital Divide: A digital Bangladesh by 2021? *International Journal of Education and Human Developments*, *1*(3), 1–8.

Wells, T. R. (2011). Sen's Capability Approach. In J. Fieser & B. Dowden (Eds.), *Internet Encyclopedia of Philosophy*. Routledge.

Westoby, R., Clissold, R., McNamara, K. E., Ahmed, I., Resurrección, B. P., Fernando, N., & Huq, S. (2021). Locally led adaptation: Drivers for appropriate grassroots initiatives. *Local Environment*, *26*(2), 313–319. https://doi.org/10.1080/13549839.2021.1884669

Westoby, R., McNamara, K. E., Kumar, R., & Nunn, P. D. (2020). From community-based to locally led adaptation: Evidence from Vanuatu. *Ambio*, *49*(9), 1466–1473. https://doi.org/10.1007/s13280-019-01294-8

Wiig, A. (2016). The empty rhetoric of the smart city: From digital inclusion to economic promotion in Philadelphia. *Urban Geography*, *37*(4), 535–553. https://doi.org/10.1080/02723638.2015.1065686

Zheng, J., Yang, D., Li, E., Ma, Y., & Wang, Y. (2024). Bridging the Digital Divide: Leveraging New Media for Rural Development. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-024-02130-5