Designing for Resilience: Fostering Ponds of Stability with Computer Clubs in Palestine

Marios Mouratidis
Institute of Information Systems and New Media
University of Siegen
Siegen, Germany
marios.mouratidis@uni-siegen.de

Clara Rosa Cardoso
Institute of Information Systems and New Media
University of Siegen
Siegen, Germany
clara.rosacardoso@uni-siegen.de

Philip Engelbutzeder
Institute of Information Systems and New Media
University of Siegen
Siegen, Germany
philip.engelbutzeder@uni-siegen.de

Peter Tolmie
Institute of Information Systems and New Media
University of Siegen
Siegen, Germany
peter.tolmie@uni-siegen.de

Konstantin Kosta Aal
Institute of Information Systems and New Media
University of Siegen
Siegen, NRW, Germany
konstantin.aal@uni-siegen.de

Volker Wulf
Institute of Information Systems and New Media
University of Siegen
Siegen, Germany
volker.wulf@uni-siegen.de

Abstract

Addressing the complexities of conflict-affected regions remains a critical challenge for Human-Computer Interaction (HCI). This paper examines the establishment of computer clubs in Palestinian refugee camps, where efforts to create sustainable interventions weighed against the instability of prolonged conflict. To capture this dynamic, we introduce the notion of 'adaptive ponds of stability,' which extends the 'tech public of erosion' framework [12]. While the latter emphasizes systemic depletion of socio-technical infrastructures, adaptive ponds of stability highlight efforts to foster temporary spaces of resilience. The clubs became hubs of learning, respite, and collaboration—offering moments of routine and empowerment amidst disruption. Reflecting on this, we advocate for a paradigm shift from sustainability to resilience as the primary design goal in unstable contexts. Our findings emphasize adaptability, local agency, and cultural sensitivity that respond dynamically to context-specific challenges, offering a nuanced approach to advancing HCI interventions in conflict-affected settings.

CCS Concepts

• **Human-centered computing** → **Empirical studies in collaborative and social computing**.

Keywords

Resilience, Sustainability, Computer Club, Marginalized Communities

CHI '25, Yokohama, Japan

ACM ISBN 979-8-4007-1394-1/25/04
https://doi.org/10.1145/3706598.3713253

ACM Reference Format:
Marios Mouratidis, Clara Rosa Cardoso, Philip Engelbutzeder, Peter Tolmie, Konstantin Kosta Aal, and Volker Wulf. 2025. Designing for Resilience: Fostering Ponds of Stability with Computer Clubs in Palestine. In *CHI Conference on Human Factors in Computing Systems (CHI '25), April 26–May 01, 2025, Yokohama, Japan.* ACM, New York, NY, USA, 18 pages. https://doi.org/10.1145/3706598.3713253

1 Introduction

Long-lasting conflicts, such as the ongoing crisis in the Occupied Palestinian Territory (OPT), create unstable environments where traditional socio-technical interventions often fall short. Deep-rooted historical, political, and social tensions shape these regions, demanding adaptive, context-sensitive approaches. This paper investigates the establishment and long-term evolution of two computer clubs for children in two Palestinian refugee camps, highlighting the challenges and adaptations that shaped their development over nine years.

Initially, our project sought to create sustainable, long-term educational spaces through technology-based initiatives in the refugee camps. However, we soon encountered significant obstacles, such as immediate needs for short-term support, complex dynamics of family and political affiliations within the camps, and persistent security concerns due to the Israeli occupation. These realities led us to critically reassess our assumptions, including our roles as external researchers and the initial naivety of our ambitions of broad-reaching, sustainable, and even peace-making impact.

This paper reflects on these challenges and advocates for a shift from conventional sustainability goals to resilience as a more practical approach for designing interventions in regions of conflict-affected settings. We draw on the concept of 'tech public of erosion' [12], which describes how external forces disrupt and reshape resources in such conflict-affected, politically volatile contexts. At the same time, we foreground the community's ongoing adaptations to such pressures. [12]. The concept of 'infrastructural inaccessibility' [9] further aligns with the conditions under which resilience in these clubs emerges, characterized by limited access to stable resources and external support structures.

To better capture this dynamic, we introduce 'adaptive ponds of stability' as a sensitizing concept (REF) to describe how the clubs provided temporary moments of normalcy, ease, joy, and learning amid constant disruption. Unlike fixed infrastructures, these spaces were sustained through the ongoing commitments of volunteers, community members, and external supporters. Though not permanent, they played a crucial role in fostering community resilience by offering children structured activities insulated from the surrounding turmoil.

By examining the characteristics and environmental dynamics of these clubs, we explore how they repeatedly dried out due to external pressures such as safety risks and resource limitations, but also refilled through community efforts and external support. Inspired by the exploration of infrastructure decline [53], we highlight how the clubs adapted to recurring breakdowns and partial resource depletion, underscoring resilience as a practice of navigating deterioration with adaptability and humility rather than resisting it.

Ultimately, this study contributes to the discourse on Information and Communication Technologies for Development (ICT4D) and crisis informatics by framing resilience as an agent-driven, iterative process. It emphasizes local agency and adaptive capacity as central to socio-technical interventions in persistently unstable regions. These insights invite a reevaluation of resilience in HCI for conflict-affected settings, positioning adaptive, localized agency at the heart of intervention design while acknowledging the limitations of external intervention. Ultimately, this study contributes to the discourse on Information and Communication Technologies for Development (ICT4D) and crisis informatics by framing resilience as an agent-driven, iterative process. It emphasizes local agency and adaptive capacity as central to socio-technical interventions in conflict-affected settings. Our findings highlight the need for humility in designing interventions, acknowledging the constraints of external involvement while centering the agency of local communities. These insights invite a reevaluation of resilience in HCI for conflict-affected settings, positioning localized adaptability at the heart of intervention design while recognizing the limitations of external intervention.

2 Related Work

This section examines the relationship between sustainability and resilience in socio-technical interventions, particularly within ICT4D and crisis informatics. By reviewing key texts, we aim to reveal the challenges and opportunities in designing resilient socio-technical systems for conflict-affected regions and relate these to our experiences in the Palestinian refugee camps. Using the sensitizing concept 'adaptive ponds of stability', this exploration provides a foundation for arguing in favor of more humble and adaptive approaches when working in persistently unstable environments.

2.1 Sustainability of ICT interventions

Although sustainability in socio-technical interventions has been relatively underexplored in the contexts of conflict zones, broader research in diverse environments offers valuable lessons for framing our work in the Palestinian region. This section explores the literature on sustainability in information and communication technology (ICT) interventions and reflects on their practical implications.

Ali and Bailur [4] identified five dimensions of sustainability within ICT4D: economic, social/cultural, technological, institutional/political, and environmental. Economic sustainability overcomes reliance on donor funding [40], while the social dimension emphasizes user engagement and relevance to local communities [20]. The adaptability and longevity of technology determine its technological sustainability [22], whereas institutional sustainability relies on acceptance by key stakeholders. Finally, environmental sustainability addresses responsible disposal and reuse of ICT equipment [30]. Beyond these broad dimensions, Atinaf et al. [8] further stressed the importance of social structures in empowering communities, allowing them to become more resourceful in the face of external pressures, and fostering sustainable interventions.

In the context of rural communities in Australia, Simpson [51] reflected on community informatics (CI) initiatives emphasizing that successful sustainability depends on physical infrastructure, soft technology, social infrastructure, and social capital, highlighting the crucial interplay between technical and social aspects. Failure, she noted, often stems from tensions between commercial and community interests, poor communication, and inadequate management. Similarly, Etta and Parvyn-Wamahiu [18] observed frequent failures of ICT4D initiatives in rural Africa due to technological and infrastructural limitations, insufficient community buy-in, and the absence of a sustainability strategy. Brough et al. [15] expanded on these findings by categorizing common failures in sustainability efforts, including inadequate stakeholder engagement, lack of long-term planning, insufficient financial resources, and deficient monitoring and evaluation mechanisms.

Fowler [19] described sustainability as a delicate balance between stability and change, questioning whether it inherently conflicts with the impermanent nature of human life and the life cycle itself, which are marked by constant transition. Ali and Bailur [4] further argued that sustainability is an unrealistic concept in ICT4D, as it is difficult to operationalize. They pointed out that sustainability models and frameworks frequently fail to predict the future or ensure the longevity of projects in rapidly changing environments. Instead, they advocated for a more flexible approach, emphasizing improvisation and the acceptance of unintended outcomes.

Research in other fields, such as healthcare, also highlights the challenges of sustainability, including resource limitations such as budget constraints and limited manpower, outdated technology, inadequate facilities, and leadership gaps [29, 39]. Work on the decline of emerging infrastructures underscores how interventions designed with longevity in mind often encounter cycles of scaling down and partial breakdown, revealing the need to balance long-term goals with adaptable practices [53]. In rapidly changing or resource-constrained environments, sustainability goals often require reconfiguration to respond to unforeseen challenges, highlighting that interventions in conflict-affected regions may encounter unique barriers to maintaining continuity.

In sum, while much of the literature on sustainability highlights diverse factors that contribute to success, it often overlooks the unique challenges encountered in conflict-affected regions. These

unique challenges are compounded in Palestine by structural limitations and political pressures. Contributions from Palestinian scholars addressing sustainability under occupation remain sparse. This limited body of work highlights the challenges specific to Palestine, where perpetual crises intersect with sustainability goals. Examples include the exploration of circular economy principles in Palestinian higher education [34], which emphasizes resilience and innovation in response to crises. Similarly, Salem [49] highlights the critical role of women in agriculture and sustainable development under occupation, addressing the intertwined challenges of resource constraints and socio-political instability. The concept of 'tech public of erosion' [12] underscores how external political and infrastructural forces destabilize public initiatives in conflict-affected settings such as Palestine, Here, we recognize that in such environments, traditional sustainability goals must give way to resilience, understood as adaptive persistence amid the ongoing erosion of resources and stability. This shift in focus, emphasizing adaptability over permanence, sees resilience as a more viable goal in persistently unstable settings. To reflect this, we introduce the notion of 'adaptive ponds of stability' to capture managed, intentional resilience sustained through local agency.

2.2 Resilience in Crisis Contexts

Sustainability, while a valuable goal, often proves impractical in unstable and challenging environments like Palestine. This makes resilience a more realistic objective. Unlike traditional sustainability models that focus on maintaining interventions and preventing breakdowns, resilience prioritizes flexibility, enabling communities and systems to recover and adjust effectively to disruptions. Boulus-Rødje and Bjørn [12], for instance, consider resilience to be continuous adaptation to external and internal pressures, rather than aiming for static stability. Others see it as a capacity to absorb disturbances while adapting and transforming in response to changing conditions [63]. Heeks and Ospina [23] discussed how resilience, as a system property, can enhance crisis preparedness and response strategies, especially in developing countries.

Lorenz [31] identified three key capacities that contribute to social systems' resilience: adaptive capacity (the ability to modify its structures proactively), coping capacity (managing past disruptions), and participative capacity (adjusting to external interventions). Together, these capacities enable social systems to adapt, cope, and interact effectively with external influences, highlighting the importance of proactive adaptation, effective coping mechanisms, and collaborative engagement in resilience-building efforts.

Some studies have explored resilience in the context of prolonged instability in conflict-affected regions. For instance, Arnall [7] explored resilience as a transformative capacity in a Mozambican resettlement program, while Young and Ismail [71] studied livelihood resilience in Darfur. Buriel [16] focused on displaced youth and collective resilience in Iraqi camps, and Ammar et al. [6] explored health system resilience amidst the Syrian refugee crisis in Lebanon. Investigating the experiences of war-affected children, Vindevogel [61] criticized resilience frameworks that focus solely on individual factors, advocating for a broader understanding of social and structural influences, and proposing a relational approach that emphasizes dynamic interactions across different spheres.

An assets-based approach, as advocated by Karusala et al. [27], highlights how resilience is not only about adaptive actions but is also deeply intertwined with socio-structural factors, such as identity and community assets, that shape individuals' and groups' capacities to be resilient. Their study of community health workers in Kenya emphasized how assets like social ties, financial resources, and institutional support are unevenly distributed and accessed, which complicates resilience practices [27]. Similarly, Vyas and Dillahunt [62] emphasize resilience as a strength-based, social process embedded in everyday life. Their work with low socioeconomic status (SES) communities in Australia illustrates how resilience is enacted through local support networks, shared resources, and social connections, which collectively help individuals navigate adversity. This strength-based approach, which foregrounds people's existing capabilities rather than deficits, aligns with our view of the computer clubs in Palestine as adaptive ponds of stability. In both cases, resilience emerges as a community-driven, care-oriented process that leverages local assets to foster stability amidst external challenges. Gui et al [21] have further advocated for a justice-oriented, multi-scalar approach to resilience, urging designers to address the socio-structural factors that contribute to adversity rather than solely focusing on individual adaptation. This perspective reinforces our emphasis on community resilience as it highlights the need to consider the broader structural challenges that shape resilience efforts in conflict-affected settings.

The crisis informatics literature predominantly addresses resilience in situations where stability is abruptly interrupted by unforeseen crises – typically acute emergencies, such as natural disasters. Examples include post-disaster recovery strategies [32], the role of cloud computing and data analytics in disaster management [52], the increasing use of social media in emergencies since the 9/11 terrorist attacks [44] and empirical insights for designing ICT for international disaster response [56]. Vali-Siar and Roghanian [59] underscored the interconnection between resilience and sustainability in supply chain networks, particularly their ability to survive disruptions. However, in Boulus-Rødje and Bjørn [12], resilience in conflict-affected regions like Palestine is seen to involve a continual response to systemic and persistent instabilities rather than isolated crises. This framework is complemented by the concept of 'infrastructural inaccessibility' [9], which highlights how limited access to foundational resources—such as reliable internet, financial services, and physical mobility—further complicates efforts to create resilient socio-technical systems in conflict zones. In environments where infrastructure is intentionally limited or disrupted, resilience often manifests as the capacity to work around persistent gaps and adapt technology to function within these constraints.

Additionally, Boulus-Rødje et al.'s study on software development collaborations between Palestinians and Israelis illustrates the unavoidable entanglement of socio-political factors within technical interventions in zones of conflict [13]. Their findings reveal that even projects aimed at fostering socio-economic development in politically fraught contexts are inevitably influenced by local power dynamics and political affiliations, adding further complexity to the concept of resilience. In our case, interventions in Palestinian refugee camps needed to not only adapt to infrastructural limitations but also navigate a landscape where political and social challenges persistently intrude on the intended functionality of

technology, underscoring resilience as an iterative adaptation to multiple forms of erosion.

While there are clear parallels between our work and that of Boulus-Rødje and Bjørn [12], our concept highlights the intentional, managed resilience efforts from within a community. It foregrounds the human agency involved in sustaining spaces as temporary refuges that are repeatedly revived through deliberate local volunteer efforts and adaptive practices.

In a nutshell, the existing literature has focused on the intricate relationship between sustainability and resilience in crisis contexts. Our research, situated at the intersection of ICT4D and crisis informatics, contributes to this discourse by exploring both the challenges and opportunities involved in fostering socio-technical interventions in conflict-affected regions. By reflecting on our experiences in Palestinian refugee camps, we emphasize the shift from sustainability, which often proves difficult in unstable environments, towards resilience as a more viable framework for creating meaningful and adaptable interventions. In addition, we expand on existing resilience frameworks by introducing adaptive ponds of stability as a managed resilience model specific to conflict-affected settings. This model emphasizes the local agency, intentional efforts, and cycles of renewal that enable temporary sanctuaries to emerge, demonstrating how resilience in these contexts is sustained through the active maintenance of temporary stability amidst persistent disruption.

3 Research Setting & Historical Context

The OPT has been shaped by 70 years of conflict and segregation. Following the Nakba in 1948, approximately 760,000 Palestinians were displaced from their homes in areas that later became Israel. They sought refuge in 59 camps administered by the United Nations across the West Bank, Gaza, and neighboring countries including Syria, Lebanon, and Jordan [33]. Originally intended as temporary settlements, these refugee camps evolved into quasi-ghetto neighborhoods, stigmatized and isolated from the broader Palestinian population [41]. Refugees residing in these camps have now formed distinct communities following their own values, norms, and practices, often disconnected from mainstream Palestinian society [1, 66]. Governmental neglect has further compounded the situation, with the PA playing no official role in camp administration [70]. Decision-making and resource distribution are managed by local committees and external agencies like the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA), but their efforts are often constrained by the broader political and military context. The Israeli Defense Forces (IDF) frequently exert control through raids, arrests of political activists, and punitive action such as house demolition and collective punishment [64].

The Oslo II Accord of 1995 divided the West Bank into Areas A (18% of the territory; under Palestinian Authority (PA) control), B (22%; with shared PA and Israeli control), and C (60%; under full Israeli control). Gaza was governed by the PA and after 2006 came under Hamas control [38]. Despite these divisions, Israel maintains considerable control, especially in security and administration, and military checkpoints continue to restrict movement and access to essential services for Palestinians, as well as economic growth [9]. These restrictions create constant stress, exacerbated by the threat of violence and military incursions [25].

3.1 Refugee Camps in Palestine

UNRWA was founded in 1950 to support the displaced Palestinian refugees with educational, healthcare and social services in refugee camps. It has become responsible for the protection of some 5.9 million registered refugees in the West Bank, Gaza Strip and surrounding countries [41]. The organization rented plots of land from the hosting governments to establish camps providing housing and infrastructure. While the camps were planned to be temporary, the UNRWA mandate has been extended every three years ever since it was first founded. Housing conditions in the camps are substandard and overcrowded. In the West Bank today, some camps have borders, gates blocking the roads and sometimes even checkpoints, while others blend into existing buildings of neighborhoods almost seamlessly.

The camp communities are marginalized and face social stigma [3] and refugee children usually grow up in schools inside the camps, such that their first social exchange with the outside population might only happen if they manage to pursue higher education. Overall, there is high unemployment and poverty amongst the camp populations and they are characterized by socio-political instability and infrastructural limitations, creating a complex environment for socio-technical interventions. As [12] note, such settings often face continuous external pressures that erode foundational structures, making permanent stability unattainable and resilience essential. The local landscape is shaped by infrastructural inaccessibility [9], with access to resources like reliable power, internet, and educational facilities remaining limited and fragmented. Various NGOs, CBOs and charities have provided regular humanitarian aid in the refugee camps to cover basic human needs.

The Jalazone refugee camp was established in 1949 and nowadays borders directly onto an illegal Israeli settlement. Figure 1 shows Jalazone and its outskirts in brown and the settlement in blue, together with a military base in red (B'Tselem n.d.). There are regular tensions regarding land use with the surrounding villages. After the Oslo Accords, the area fell under joint Israeli-Palestinian control (Area B). Due to the ongoing growth of the nearby settlement, the camp suffers from almost daily confrontations between residents and the IDF. Military raids in the camp are frequent. Moreover, the camp's boys' school is located directly in front of the settlement, creating additional security concerns. Up to the first Intifada, Jalazone's population used to work in nearby settlements and Israel. After the Intifada, these opportunities dried up, leading to high levels of unemployment.

The Am'ari refugee camp, also established in 1949, is located east of Ramallah city in al-Bireh municipality is and considered one of the smallest camps concerning plot size and its estimated population density (c. 160 per km^2). While its residents had many opportunities to leave the camp before the first Intifada, the construction of the West Bank Barrier and expansion of the cities around it led to increased property prices, making it impossible for most residents to move out. After the Oslo Accords, Am'ari was placed in Area A under PA control. However, its residents claim the camp is neglected. Moreover, despite the PA control, there was regular IDF military

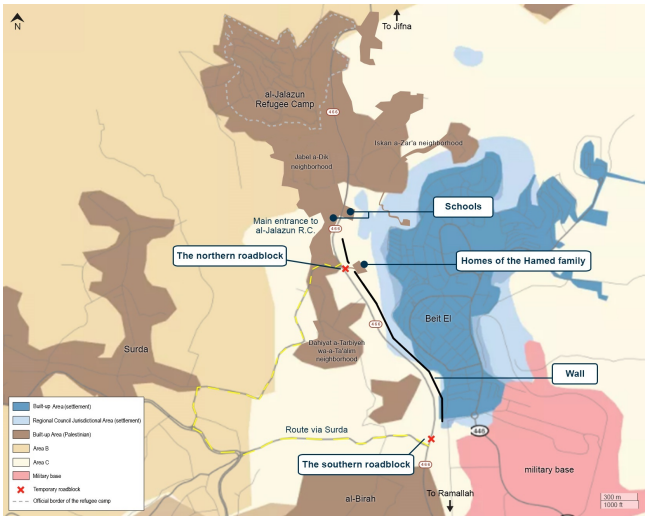

Figure 1: Map of Jalazone and local travel restrictions. (Source: btselem.org)

activity, with incursions, detentions, and home demolitions during the period of our research. The camp residents are mostly Fatah-affiliated.

3.2 Computer Clubs in Palestinian Refugee Camps

Computer clubs were originally established in Boston in 1993, through a collaboration with the MIT Media Lab. They were designed to offer technology-focused, after-school spaces for urban youth [42, 48]. Emphasizing constructionist principles, they encouraged participants to pursue personal interests and collaborate within a supportive community [43], fostering problem-solving skills and creative expression through hands-on learning, supported by adult mentors [26].

In 2003, the MIT model was adopted in Germany, shifting the aim to address isolation and educational disparities in ethnically diverse communities [54]. Framed within a socio-informatics perspective [69], they promoted intercultural understanding through collaborative computer-based projects, leading to the establishment of multiple clubs across the country [60]. Activities included programming, multimedia projects, and intergenerational learning [60, 65, 67].

The computer club model was later adopted once more for Palestinian refugee camps. Here they faced unique challenges due to socio-political instability and resource limitations [3, 55]. This aligns closely with the 'tech public of erosion' framework [12], as computer clubs in Palestine encounter constant dismantlement and renewal due to external pressures. Here, resilience is less about achieving long-term stability and more about building adaptive capacities within the community, fostering engagement and learning even as resources fluctuate. In Bjørn and Boulus-Rødje [9], the notion of 'infrastructural inaccessibility' was introduced because the clubs were operating within a public where access to necessary resources was frequently constrained by external political and economic forces, necessitating that resilience take the form of adaptability and flexibility. The ongoing adaptations of these clubs echoed Steinhardt's findings on the reconfiguration of infrastructure, where cycles of decline and renewal are part of maintaining functionality [53]. Rather than seeing decline as failure, these cycles underscore a club's resilience in creatively navigating erosion to create temporary but meaningful spaces for learning and community engagement.

In our case, a group of researchers from Germany approached a Palestinian University with the idea of setting up computer clubs in the camps. Our Palestinian partners recommended speaking with stakeholders from the municipality about permission to set them up. The government representatives welcomed the initiative and forwarded it to a contact person as a gatekeeper in each of the camps. The selection of the specific two camps was based on recommendation from a PA representative.

Identical technology was deployed in both computer clubs: two servers; ten thin-client-based workstations; and a set of electronic learning kits [3, 70]. Thin clients were used to deter theft.

After two years of preparation, the first club was established in 2012 in the Jalazone camp, which later proved particularly difficult. Jalazone was considered very dangerous, especially due to its proximity to an Israeli settlement and military base. The residents kept to themselves and were very cautious about outsiders (including Palestinians). Student volunteers were also reluctant to visit. Initial talks through the Palestinian partners were slow and multiple visits were undertaken before the first activities could start. The club was located in a building that housed the Camp Services and Administration Council. An NGO was established by the locals to administer the club and to be able to apply for more funding when needed.

Activities in Jalazone were led by volunteer students from the local university. As part of their study program, they were required to complete so-called "community service" by volunteering in social projects. Supporting the computer clubs was offered as one such project. They were trained to facilitate sessions as tutors, and then organized and led activities independently. Usually, five tutors hosted one session with around 20 children. During the next four months, the participants met on Saturdays to work together on different technology-based projects. Initially run as mixed-gender sessions, the club ultimately returned to segregated groups to acknowledge local social norms, the local camp community being very conservative. The club also joined the local University's 3-week summer program, offering daily sessions on campus, where the children learned programming and robotics, met students, and experienced university life.

After the club in the Jalazone camp was established, planning for a second club in Am'ari began, with its activities starting in 2013. In Am'ari, the team of Palestinian partners, particularly the student volunteers, faced hostility and violence during their initial visits. This led to discussions with the camp council and, after the talks and word of mouth being spread regarding the activities with the children, the project was welcomed. Although the activities were met with excitement, parents of the participants raised concerns about internet access and, once again, gender segregation [55]. The internet was considered dangerous because there were fears its content would have a negative impact on children. Things

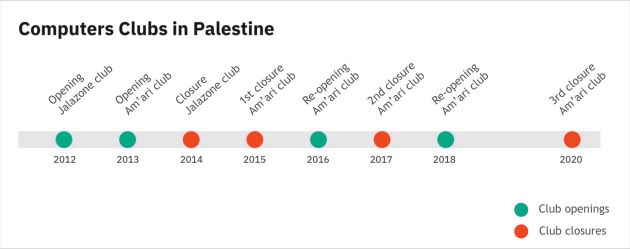

Figure 2: Timeline of Computer Clubs openings and closures

were facilitated here by a youth center administrator who attended some sessions and was affiliated with the most influential family in the camp, which inspired greater trust. In this case, mixed-gender sessions were ultimately allowed.

In both camps, the vision was to undertake technology-supported, project-based activities that might promote integration through meaningful exchange. By focusing on children, our approach aligned with the computer club concept of engaging broader communities by first involving their youngest members in playful, hands-on learning activities.

4 Methods

To develop a comprehensive understanding of the research environment and to foster trust with various stakeholders, we adopted two complementary approaches beyond the development of the computer clubs: (1) approximately six-week periods of immersion to build an ethnographic account of life inside and outside the camps [45], and (2) participatory action research (PAR) to involve local stakeholders in shaping the intervention [28]. This combination of methods reflects the need for adaptive, responsive approaches when conducting research in environments where a range of internal and external pressures can shape the intervention's feasibility and direction [12, 47].

The ethnographic research involved participatory observation, interviews, and informal conversations, where researchers engaged directly with community members to understand their everyday life, cultural practices and norms, and social dynamics [36]. This brought insights into all of the stakeholders' perspectives [45]. By living in the environment, researchers observed firsthand how adaptive behaviors emerged in response to the structural instability within the camps, capturing the resilience mechanisms in play. Social ties with locals were also established, beyond the computer clubs, with neighbors, local shop owners and people from our partners' networks, and a number of firm friendships were established. Researchers attended colloquia at the university with their friends, followed personal interests, and explored the local nightlife. Social ties were kept alive between field trips through social media. Daily local news was consumed while away as well, offering an opportunity to exchange on mutual topics from afar. Language barriers were addressed by relying heavily on local gatekeepers, who translated during interviews and conversations and contributed field notes with observations of interactions with children and partners. They also engaged in ongoing discussions with the researchers, providing valuable context and insight into local cultural dynamics and issues.

PAR emphasizes active collaboration with local stakeholders, integrating their insights into the research process and ensuring their participation in decision-making and problem-solving [57]. This approach allowed us to adapt the intervention iteratively through cycles of planning, action, observation, and reflection, refining it based on local needs and feedback. This gave particular insight into the resilience required as each phase of the intervention responded to the unique sociopolitical and infrastructural pressures shaping the local environment.

The project progressed through multiple phases, starting with the establishment of computer clubs between 2012 and 2013, followed by a hiatus in 2014 and 2015, with further investigations continuing until 2019 [2]. Different research teams contributed to each phase, and two core researchers provided consistency throughout. Two more researchers served as guides and intermediaries between new researchers and the local context. Annual six-week field trips facilitated ongoing engagement with the community. Before each field trip, new members of the group received briefings on the local context and culture, as well as the methodological approach. During field trips, the research group established the habit of meeting every one to two days, mutually reflecting on experiences and the gathered data. After each field trip, the data was discussed in a debrief. The methodological approach and its implications for the researchers have been reflected on an international level with a diverse audience [37].

4.1 Data Collection and Analyses

Over nine years, the data collection incorporated the following qualitative materials:

- *Participant observation:* Active observations were carried out by Palestinian facilitators, while passive observations were conducted by German researchers and student volunteers. These observations captured everyday interactions, social dynamics, and cultural nuances within each camp [11, 57, 68]. Active observations involved direct participation in club activities, while passive observations allowed for documenting spontaneous community interactions [5]. Throughout this process, the research team maintained daily field diaries to systematically record insights, reflections, and observations regarding both formal club activities and informal interactions. These diaries were crucial for tracking evolving dynamics and documenting the longitudinal progression of the intervention.
- *Interviews and informal conversations:* Structured and semi-structured interviews were conducted with 79 participants (some multiple times), including children, volunteers, camp administrators, and university partners. Due to the involvement of different researchers over the years, it is difficult to provide an exact count of interviews conducted. These interviews explored various topics, including the operation of the computer club, daily cultural and social dynamics, and participants' engagement with technology in spaces such as hackerspaces. Additionally, informal conversations often provided nuanced insights, offering a deeper understanding of participants' experiences, particularly their use of technology, social media, and the challenges of isolation within the

refugee camps. Structured interviews followed a consistent question set to ensure comparability, while semi-structured interviews allowed for a more open-ended exploration of participants' perspectives [24].

- *Visual data:* More than 2000 photographs and videos captured the environment, activities with the children, and interactions within the camps. These images were used both as data for analysis and to provide visual context for understanding the camps' conditions.

This rich dataset enabled us to gain in-depth insights into the everyday lives of camp residents, their engagement with the computer clubs, and the broader social and political environment. Despite communication challenges and the difficulties of conducting interviews in such a context, the research team succeeded in documenting contextual nuances and fostering iterative insights. The workshops training local tutors and reciprocal learning occurring through exchanges with German computer clubs served as an additional data source.

Data analysis was carried out using qualitative coding methods to systematically interrogate the rich dataset. We employed MaxQDA software to assist in its organization and followed a general inductive approach to the analysis [58]. This enabled us to distill the large volume of raw data into clear, concise thematic categories directly related to our research objectives. The analytical process involved three key steps: (a) condensing the material into a summary format, allowing us to manage its complexity; (b) establishing explicit links between the research objectives and emerging themes, with a particular focus on how the findings related to the fostering of resilience through socio-technical interventions in conflict-affected communities; and (c) developing a framework for comparing and understanding the diverse experiences and processes revealed through the data, providing deeper insights into how resilience-building mechanisms operated in the specific context of the refugee camps.

Through the above process, themes of adaptability and managed stability emerged as dominant, which aligns with the 'public of erosion' framework [12]. Further analysis of how this played out in the local context led to the emergence of 'adaptive ponds of stability' as a sensitizing concept deriving from Blumer [10] and Bowen [14]. Sensitizing concepts provide general reference points that guide researchers in identifying patterns and making sense of context-specific phenomena. Unlike definitive concepts, which impose fixed categories and rigid interpretations, such concepts allow for flexibility and adaptability, particularly suited to dynamic and unstable contexts such as the Palestinian camps. Thus, we came to see how temporary spaces of stability were being intentionally created and sustained within an environment shaped by persistent instability.

4.2 Ethical Considerations and Researchers' Positionality

In conducting this research, we recognized the complexity of the socio-political environment in the Palestinian refugee camps, as well as the potential power imbalances between us, the external research team, and the local community. Given the nature of the study, it was crucial to ensure that our research followed strict ethical standards while remaining culturally sensitive and respectful of the participants' lived experiences.

We adhered to the ethical guidelines established by the affiliated university, ensuring that all participants were fully informed about the study's objectives, their role, and their right to withdraw at any time. Informed consent was obtained from all participants before data collection. Additionally, pseudonyms were used for individuals and the camp context to protect identities, and confidentiality was maintained by securely storing all research data.

To further ensure ethical integrity, the research team collaborated closely with Palestinian gatekeepers and local partners throughout the study. These partners played a key role in facilitating culturally attuned interactions.

Researchers also made efforts to mitigate potential biases and power imbalances that come with external observation, particularly given the political tensions and forced displacements inherent to the region. Spending extended periods in the camps allowed us to develop a deeper understanding of the participants' experiences, though we remain conscious of the limitations of our position as outside observers. By incorporating local partners into the research process and reflecting on our positionality, we aimed to minimize these limitations and contribute to an accurate representation of the community's perspectives.

In addition to securing consent and anonymity, we respected cultural norms throughout the study. The authors continuously sought feedback from local stakeholders to ensure the research aligned with the community values. All participant quotes included in this paper were carefully translated by trusted local gatekeepers, ensuring that quotes and insights were accurately translated from Arabic to English without losing cultural nuance. These measures helped safeguard participants' rights and dignity while maintaining research integrity. When studying socio-technical systems and political work related to ethnicity, and religion, as is the case in Israel-Palestine, it is important to reflect on the authors' race, ethnicity and religion, and the affinities they might create [36]. They are a diverse group of researchers from various fields (Human-Computer Interaction, Informatics, Humanities), with varying nationalities and backgrounds (from Greece, Brazil, Germany, and of Palestinian descent) and religious beliefs (Christian, Muslim, atheist). The experiences on-site allowed the researchers to better understand motivations, values, and behaviors and navigate the field in a culturally sensitive manner.

5 Findings

As noted above, we use 'adaptive ponds of stability' to characterize certain moments witnessed within the clubs. The clubs provided spaces offering ease and joy for their participants, even while surrounded by a very turbulent environment. This section explores the genesis, essence, environmental dynamics, and eventual cessation of these clubs, highlighting both partial successes and unanticipated outcomes.

5.1 Genesis

Initially, the clubs were conceived as part of a broader peace-building and integration initiative, leveraging the successful model implemented in Germany. The original aim was to create long-term

sustainable spaces that foster enduring social and educational development. However, the camps' unstable environment transformed these ambitions. Within this 'tech public of erosion' [12], the clubs shifted from intended permanent spaces to 'adaptive ponds of stability'. Instead of becoming permanent, sustainable spaces for long-term education and integration, the clubs evolved into intentional, temporary refuges, actively maintained by committed individuals who offered children a space for learning, collaboration, and moments of normalcy amid the ongoing chaos. While providing temporary relief, the clubs also fostered long-term impacts, such as inspiring participants to pursue an education in computing or developing skills that extended beyond the club's immediate context. The club's resilience hinged on the deliberate, ongoing commitment of volunteers and local actors, responding to community needs and dedicating to creating meaningful impact. This active local agency emphasizes that resilience is a cultivated process, where temporary stability arises through intentional stewardship amidst challenging conditions.

As sites of temporary respite and structured activities, the clubs contrasted sharply with the chaos of the participants' everyday lives. One participant expressed processing experiences in the club session, saying: "I like to write stories in the club about the occupation, about our difficulties and life here in the camp. Like the one about when the boys threw stones at the soldiers". The relationships formed through the clubs extended beyond the workshops themselves, creating a support system for the children. As another child explained, "When I missed a workshop, the volunteers found out it was because my cousin had been killed by the Israelis, and came to stand by my home." These comments illustrate how the clubs had an unanticipated role in the lives of the children, serving not only as spaces for learning but also as places that fostered care and coping. Initially, we had hoped the clubs would contribute to long-term peace-building and sustainability, but as our involvement deepened, it became clear that these ambitions were too optimistic in the face of the ongoing instability. Instead, the clubs had a transient but meaningful impact by offering spaces or activities where children found brief relief and a sense of normalcy amid the turmoil of their daily lives.

The club sessions were run weekly by university volunteers from the local university. They used their free time in the afternoons to engage children in those activities that fostered collaboration, creativity, and digital literacy. As one child commented, "I learned cooperation, how to work in a group and divide tasks, and how to introduce myself in front of others. I believe this has greatly improved my personality." The structured weekly sessions helped the children develop new skills and gave them a break from the harsh realities of camp life.

The socio-political environment in the camps, marked by a juxtaposition of victimhood and valor among the residents, played a significant role in shaping the need for these spaces. Living conditions in the camp were dire, characterized by resource scarcity, and frequent exposure to conflict and violence. One vivid example of this contrast occurred during a field trip near Am'ari, when researchers and volunteers heard gunfire in the background, while the children inside the clubs worked on their projects in relative calm. External 'pollutants' sometimes disrupted the clubs' operations. At times, the clubs had to cancel sessions due to clashes between Palestinian youth and the Israeli military or due to collective punishment through the demolition of a home in the camp, demonstrating the constant unpredictability of life in the camps.

Figure 3: Impressions of neighborhoods in Am'ari refugee camp

Another notable instance involved children designing and building a bench from plastic bottles, old palettes, and car tires during an upcycling design workshop series [66]. "You should feel like sitting comfortably at the beach, with a lot of space. We cannot go there.", a participant stated. The camps are cramped, with densely packed buildings. The children's families come from regions along the Mediterranean coast, which they are barred from visiting due to their refugee status and lack of necessary visas. The growing number of children eager to join the workshops reflected their desire for a break from their daily struggles. Volunteers frequently reported difficulties in starting the sessions due to the children's excitement, underscoring the positive, joyful atmosphere that the clubs fostered. The children's enthusiasm and the volunteers' dedication played crucial roles in forming these ponds. The regular attendance, engagement in activities, and the creation of a supportive community were all driven by the participants themselves.

Inspecting the above findings, it can be seen that the computer clubs did not simply emerge as temporary safe spaces in an unpredictable environment. Instead, they became sites of managed resilience, heavily reliant on the commitment and ongoing dedication of volunteers. Volunteers constantly adapted resources and activities to sustain engagement. Thus, resilience here was a managed process rather than a passive, serendipitous occurrence. This managed stability was particularly visible when individuals took ownership of the clubs, replenishing resources and ensuring continuity amid external pressures. For instance, several volunteers provided logistical support and organized consistent programming activities, thereby maintaining the clubs' presence in the children's lives.

5.2 Essence

The special atmosphere of the computer clubs stemmed from their role as playful, hands-on environments that insulated children from their daily struggles in the camp. At their heart, these clubs served as more than just educational hubs; they became social sanctuaries that provided children with both emotional relief and creative expression in an otherwise tumultuous environment. Like a pond filtering out impurities, the club offered all stakeholders (volunteers and children alike) opportunity for social moments, which would otherwise not occur in their individual environments (inside vs.

outside camp), such as birthday celebrations and small gatherings. A volunteer noted, "Kids became friends by participating in the club. We were also invited to their family meetups or lunches to talk about the computer club." This ongoing dedication provided the foundation for resilience, transforming the clubs into spaces where temporary relief could evolve into lasting influences on the participants' lives. The volunteers' commitment and sense of responsibility continually helped to restore the special atmosphere and "refill the pond". A volunteer said, "I find teaching entertaining, but I think it is also fun for the children." The clubs transformed into more than just places to learn about computers; they became a social hub, a place where children could interact, relax, and bond with their peers in ways they could not in their normal, stressful lives. One participant said, "We were waiting for it [the workshop] " and that, despite the regular power outage following the sessions, they chose to stay at the club and continue playing together in the children's yard. The social fabric of the computer clubs consisted of four main groups: the primary stakeholders in the initiative including the camps' community, partners inside the camps, (i.e. the NGOs in Jalazone and Am'ari where club sessions were hosted), project partners from the Palestinian university, and the student volunteers. Each group played a critical role in sustaining the clubs, contributing to their vitality and resilience.

The camps' communities, balancing a dual identity of victimhood and valor, sought to highlight their plight to the outside world. One informant explained,

> *Living in a camp means being forced from your home and living in a place with many basic needs missing. This creates a sense that people outside should help, and feelings of dependence. Most refugees dream of escaping the camp's poverty and oppression, but the camp becomes their identity, defining their struggle.*

To cope with these dire conditions and the lack of internal resources, camp residents often sought external advocacy by engaging prominent artists and international politicians to draw attention to their struggles. Another informant commented, "Inside PA, employees with a refugee background never get higher decision-making positions. Since they are not included, the society sees it as a dangerous place they should not go". These conditions made the clubs even more valuable, as they provided children with a brief escape from the stigmatization and exclusion they faced daily.

The partnerships within the associations that housed the clubs in the two camps were critical in establishing trust between the external researchers and the camp residents. However, this trust was not easily built. Initially, there was skepticism in Am'ari from both sides: volunteers were frustrated by the perceived lack of commitment from the NGO administrator in the camp, while the administrator doubted the volunteers' intentions: "I think she only comes to take selfies". These toxic perceptions threatened the project's stability but were eventually resolved through open dialogue between the German researchers and a student volunteer, leading to a deeper partnership. This collaborative effort led to tangible improvements in the club's environment, such as contributions for refreshments, technology upgrades, and space renovation, all of which enhanced the children's experience.

The role of the Palestinian university was essential in dismantling stereotypes and fostering solidarity between university students and camp residents. Volunteers from the university were able to immerse themselves in the camps' dynamics, fostering a sense of social responsibility and deeper empathy among the participants. The university's involvement also provided a structured framework, ensuring that the activities were aligned with educational objectives and community service requirements of the various study programs. Despite the hurdles faced, the student volunteers demonstrated resilience and commitment to the children, embodying a shared rhetoric of the Palestinian struggle. Their efforts acted as a 'purifying force', counteracting the 'pollutants' of skepticism and mistrust that initially existed between different stakeholders.

Throughout the project, we emphasized to our partners — volunteers, community members, and the university — that the initiative was theirs to own and sustain. Our role was to support their efforts and facilitate their autonomy. This approach empowered the local community, giving them a sense of ownership and responsibility for the project's continuity. However, this collective effort was not without its challenges, as the clubs faced ongoing obstacles related to resource limitations and differing perspectives among stakeholders. Despite these challenges, the clubs fostered a supportive network that enabled them to operate successfully, at least temporarily.

The creative hands-on nature of the workshops — featuring activities like coding video games, 3D printing toys, and practical circuit system games — became central to the club's essence. These activities served as a filtration system, removing the pollutants of daily hardships, and provided children with a sense of joy and empowerment. One child recalled, "I remember once the volunteers asked us to complete a task for the first time, and I felt like a hero because I was the first to finish it." Personal stories from the children further highlight the impact of these spaces. Two sisters who participated in the club at the age of 10 shared, "Usually people think that she's a shy person, but such workshops changed her to be more social. Also, it affected my grades in school", with one explaining how she was able to complete extra tasks assigned by her technology teacher.

Figure 4: Workshop with simple electronics kits in Am'ari camp

For some children, the clubs provided their first exposure to computers and other digital technology. The excitement of meeting university students for the first time and learning about circuits and video game design opened up new worlds for them. Some children expressed a newfound interest in pursuing computer science at the university level. "I want to learn IT and work with computers at the university", said one child, reflecting the transformative potential of the clubs.

Creativity and self-expression were also encouraged. When asked about the difference between the school and the volunteers' approach in the workshop, one participant stated, "In school, there are a lot of rules and everyone works to be the best, but here we all work and learn together." Another noted, "In the technology class at school, there's no creativity; we just learn things in theory. In the computer club, we think creatively and learn new things". In a workshop on sustainable crafting, children from both camps exchanged ideas remotely about their environment and projects. They filmed and sent short videos to one another, fostering dialogue and offering a glimpse beyond their confined surroundings. This interaction, along with their exposure to university volunteers from different backgrounds, broadened the children's worldview. Like a pond ecosystem absorbing and transforming external inputs, one participant noted, "I learned that not everyone who doesn't speak Arabic is Israeli, which opens your mind to different cultures." The 'pollutant' of social norms initially affected some participants. One stated, "Coming from a closed society, it was my first time interacting with boys outside of my family members, so I was shy in the beginning, but I changed after a while."

Some participants found opportunities to apply the skills they acquired in meaningful ways, making some positive contributions to their personal journeys and potentially impacting community dynamics. "You showed me a different aspect of computer science", said a volunteer to a local coordinator. Illustrative examples include a volunteer who had been involved in the club, and later led a week-long workshop for UNRWA, engaging 200 children in activities similar to those conducted at the club, such as Scratch programming and crafting. Another volunteer traveled to Germany, where she learned to operate a CO2 laser cutting machine at the university Fab Lab, learning about digital fabrication. Upon returning to Palestine, she transferred those skills into her own business focused on designing, producing, and distributing artisanal and promotional products. She invested in a CO2 laser cutting machine to manufacture these items, illustrating how skills gained in the clubs were applied beyond the immediate context of the camps.

While the ponds provided valuable respite, they were not immune to the harsh realities of their environment. Just as a pond can be affected by external pollutants, these spaces faced disruptions from ongoing conflict, resource scarcity, and social tensions. These "pollutants" occasionally seeped into the clubs, temporarily clouding the clarity and calm they sought to maintain. The challenges were not limited to external pollutants but also arose through internal imbalances. For instance, the growing number of excited children eager to participate in the activities often made it difficult to maintain focus during the sessions. When asked about his favorite thing in the club, one child said, "I like entertaining myself by playing games" but continued "When the work starts, everyone is still talking and I don't like that. I want to concentrate, which means everyone should be quiet so I can hear." Volunteers noticed that many children attended the clubs for social interaction. One volunteer recalled, "Kids do not come to learn, but to play and socialize".

5.3 Environmental dynamics

The success and impact of the computer clubs as adaptive ponds of stability cannot be fully understood without exploring the environmental dynamics that shaped their operation. Several factors, including the network of people involved, the clubs' structural organization, and the external socio-political pressures, contributed to both their temporary success and decline. Despite facing logistical challenges such as language barriers between researchers and local parties, competition among volunteers, and financial constraints, the clubs generally held regular sessions. Each session represented a collective effort to reestablish stability, embodying resilience as the volunteers worked to create meaningful experiences under shifting conditions. This resilience exhibited not only a determination to preserve stability but also in a sustained commitment that enabled long-term impacts on participants' learning and personal growth.

The workshops were led primarily by volunteers from the Palestinian University, some of whom had a refugee background themselves. However, the challenges they faced were far from trivial. The most significant hurdles related to funding, mobility, and safety. Volunteers often found it difficult to cover the transportation costs to and from the camps. A local project coordinator remarked, "Usually, students don't go to refugee camps because it is considered a dangerous place. So if they can, they will avoid the camps." Security concerns were a constant, with volunteers having to navigate military checkpoints and, at times, leave the camps due to clashes between Palestinian youth and IDF. This challenge can be seen to extend to traveling in the West Bank in general. Some volunteers lived in villages in Area C, creating a potential for encountering closed checkpoints or other issues like random checks and traffic jams. During one session, the workshop had to abruptly end due to an outbreak of violence nearby. Safety concerns were beyond the control of the volunteers and could not be directly addressed, but the club adapted by integrating these challenges into its operations, rescheduling or adjusting sessions as needed. One could say that the general stance of the volunteers was to always expect unexpected disruptive events.

Regardless of these challenges, many volunteers demonstrated a deep commitment to the project. After the closure of one of the clubs, one volunteer said "I did not get anything for working there, I just loved the work. I think they should re-open, it is a big thing, teaching the kids." This dedication is further reflected in the structured approach that volunteers adopted for each session. The workshops typically lasted around 1.5 hours, starting with a few minutes to allow the children to settle at their workstations and play a few games before diving into the more focused activities. A volunteer explained, "The kids are difficult to control, they are just kids. . . But maybe their tough life experiences make them harder to manage." Certain aspects of this can be seen to reflect the need for continuous adaptation from volunteers and community members despite limited resources discussed in Boulus-Rødje and Bjørn [12].

The children consistently viewed the clubs as both social and educational spaces, where they could learn new skills and interact with peers in a safe and engaging environment. The combination of play, and learning about technology created an atmosphere that encouraged exploration and curiosity. The engagement of volunteers, on the other hand, evolved, reflecting a growing sense of ownership and a willingness to adapt to the shifting needs of the participants. Volunteers increasingly developed new ways to connect with the children and keep them engaged. However, their motivation shifted over the years. While reimbursements for commuting, as well as credit for community service hours for their studies were initially available from the University, after 2016 this support dried up. The volunteers then began to reorganize by recruiting new members through the university and also reaching out to other volunteer communities like traditional dance clubs or relief organizations. Their deepening commitment was evident in their ability to modify activities and adjust to the children's emotional and behavioral responses, creating a flexible learning environment that remained responsive to the volatile surrounding context.

The clubs also became a resource for building emotional and social resilience. Children used creative outlets like 3D printing and Scratch programming to design things such as 3D models of a truck carrying a rocket or a Scratch game where the controllable character threw rocks at a tank. These creations reflected the children's efforts to process and make sense of the tumultuous environment in which they lived through their engagement with technology. As they built stronger relationships with volunteers and peers, these social bonds provided a support network, helping them navigate the challenges they faced. Over time, the clubs fostered not only individual resilience but also collective strength, offering a vital space for personal growth and coping with adversity.

Despite everything, the clubs remained committed to offering the same core activities until the end of the study. While the volunteer group changed over time, with new members joining and others leaving, the workshops maintained a consistent focus. Analysis of participant engagement revealed sustained involvement in the computer clubs, with most children attending regularly for the full two-year program. This occurred despite occasional fluctuations due to local circumstances, such as family commitments, political tensions, or temporary absences. The longevity of engagement and subsequent career paths of several participants—including those who pursued higher education in computer science or launched tech-related businesses—underscore the clubs' lasting impact. While quantitative metrics were not the focus of this qualitative study, the observed patterns of attendance and narratives from participants testify to the clubs' positive reception and potential impact. Limited resources, however, constrained the capacity to monitor progress after participants' involvement in the clubs had ended.

5.4 Dry Out and Refill

Like natural ponds occasionally dry up under certain conditions, the computer clubs in the Palestinian camps mirrored this cycle of fluctuation. They provided moments of stability and respite, yet, echoing Boulus-Rødje and Bjørn [12], were equally subject to external pressures that caused them to "dry out." These external pressures acted as pollutants, threatening the stability of these adaptive spaces. The clubs depended on the persistent efforts of volunteers who navigated cycles of resource scarcity, security challenges, and community dynamics to revive the clubs after each cessation. Like ponds refilling through rain, the club at the Am'ari camp was repeatedly revived, showcasing the resilience of the community and the ongoing efforts to provide this vital space amidst instability. Cycles of cessation and revival occurred three times in Am'ari, in 2016, 2018, and 2020 (see Fig.1). These efforts to re-establish the sessions relied on a growing network of stakeholders, including new and returning volunteers, the local university, local partners, and organizations providing space. A coordinator in Am'ari remarked, "They believed in us. They were proud of the project." Adaptations made to revive the clubs included attempts to improve the technology used and refining the volunteer selection process to ensure genuine interest and experience. Responsibility for and ownership of the project was passed to the volunteers, away from the researchers. An open conversation with the NGO coordinator in the camp also clarified that our primary role as external collaborators was to support the local community in developing an autonomous model, utilizing local resources, and building up local capacities to ensure continuity and self-financing capabilities.

Sadly, in the case of the Jalazone camp, communication with local partners was lost and never restored, so it remains uncertain whether the club continued, adapted, or dried up entirely. The cessation appeared to result from conflicts between the club's coordination and the association providing the space, linked to the camp's popular committee and internal community disputes. One local coordinator said, "In Jalazone we had the wrong partners. You need to involve the stakeholders."

The political landscape of the camps often influenced the clubs' social dynamics. Participation was frequently limited to children from certain political factions. For example, most participants in Am'ari came from Fatah families due to the Fatah-aligned management of the NGO partner. One facilitator noted the lack of diversity, saying, "It's always children from (t)his family", highlighting the challenge of engaging a broader community. We have already seen how efforts to create mixed-gender sessions and unite children from different political backgrounds faced resistance due to prevailing societal norms and political tensions.

Outside of these political issues, financial constraints were a primary issue, such as the volunteers finding it difficult to continue due to a lack of funds for transportation. External safety concerns exacerbated the situation, but interpersonal conflicts among stakeholders also strained operations. These internal tensions acted as corrosive agents, undermining the clubs' stability. For example, disputes over power, hierarchy, and personal recognition led to reduced morale among volunteers. One child participant recalled: "Once, they [volunteers] had a problem between them and had to cancel the session." At times, a volunteer's contribution was overshadowed by another's desire for control, leading to friction within the group. A notable example involved a volunteer deleting a colleague's announcement from the club's Facebook group, followed by a private message stating: "Coordination is none of your business".

Resource limitations also played a significant role in the decline of the clubs, acting as a slow-acting pollutant, gradually undermining the clubs' ability to function effectively. After one of the

closures, a few volunteers continued leading sessions for an additional three months. One stated, "We like this project, we have been involved from the start, and we want it to continue." However, without financial support for transportation or formal recognition for their work, maintaining this commitment became increasingly difficult. Regarding the technological infrastructure, the initial setup of servers and thin clients in Am'ari was no longer functional after one server broke down, and the operating system on the second server was erased. Attempts to reinstall the system were hampered by a lack of drivers for Windows 10 and security risks with Windows XP. When it was suggested to switch to Linux, the volunteers hesitated, noting, "We only learn about Windows servers at university, no one knows Linux around here". In 2017, the thin clients were replaced with Raspberry Pi 3 systems running Linux. Interestingly, the children adapted to this new setup with ease, highlighting their adaptability and eagerness to learn.

Environmental pressures continued to pose significant challenges and a visit in 2018 revealed that several computers were missing or malfunctioning, which further disrupted club activities. Security risks, including the risk of arrest and violence, never disappeared. One volunteer recounted an incident in Am'ari, where camp youth attacked the group, leaving one volunteer injured. Although these attacks stopped after discussions with camp elders, the fear remained, adding to the already difficult environment in which the volunteers operated. As a volunteer remarked, "Some [students] rather go clean streets for community service hours than go inside a camp".

The camps' economies, heavily reliant on external aid, posed challenges as well. While international NGOs provided essential services and funding for initiatives like libraries and children's centers, this reliance fostered a sense of dependency. A prevalent mindset was to seek out new initiatives to secure fresh funding rather than focusing on sustaining existing projects. This was reflected in a comment from a teacher to a Palestinian student volunteer: "Make them bring their money to us." Once external funding for the computer clubs dried up, interest in sustaining the project waned, and attention shifted to other ventures that promised fresh partnerships and visibility.

6 Discussion

In the above findings, we have seen how the ponds emerged as temporary sanctuaries amidst ongoing instability, that could offer children brief moments of normalcy and learning. These spaces were actively constructed and maintained through the dedication of volunteers, particularly university students. Key characteristics of these ponds included their ability to provide emotional relief, creative expression, and social interaction for children in an otherwise tumultuous environment. They served as playful, hands-on environments that insulated children from daily struggles. Several factors shaped these adaptive spaces. The socio-political context of the camps, marked by resource scarcity and frequent conflict, heightened the need for such refuges. The commitment of volunteers, support from local NGOs, and partnerships with universities were crucial in sustaining the clubs. Children's enthusiasm and active participation also played a vital role in shaping them. However, the ponds of stability faced significant limitations. They operated in highly unstable environments and were frequently interrupted by conflicts and resource constraints. Initially conceived as long-term peace-building initiatives, they evolved into temporary interventions due to the persistent regional crisis. Their sustainability was complex. While they provided temporary relief and fostered long-term impacts like inspiring educational pursuits, their continuity relied heavily on ongoing volunteer efforts and community support. The clubs' resilience was not passive but actively managed, requiring constant adaptation to changing circumstances. They therefore demonstrate the power of intentional, community-driven initiatives to create meaningful impact amidst adversity. Their cyclical nature underscores the managed aspect of such ponds. Rather than drying out solely due to external pressures, they often ceased operations when dedicated individuals were no longer able to sustain them or when resources were exhausted. Conversely, the clubs were revived when individuals with renewed commitment and fresh resources emerged, exemplifying how resilience in this context is not purely circumstantial but managed through human effort. This agency-driven perspective highlights that resilience, in these ponds, relies on the presence of key individuals who have both the will and capacity to re-establish such temporary sanctuaries.

In this section, we take a slight step back to reflect on the evolution of our initial ambitions for the computer clubs as sustainable, resilient, peace-building initiatives, into 'adaptive ponds of stability' — temporary spaces offering moments of joy and routine amidst the chaos of camp life. Drawing on the notion of 'tech public of erosion' [12], we see such clubs to be adaptive socio-technical spaces that continuously respond to external pressures and socio-political constraints, transforming into "publics" that emerge within the instability of the refugee camps. Our experience provides insights into the challenges of implementing socio-technical interventions in conflict-affected regions, connecting our findings with existing literature on sustainability, resilience, and ICT4D. By detailing the genesis, essence, dynamics, and drying out phases of the ponds, we contribute new insights to the existing discourse on resilience and sustainability in ICT4D, offering a deeper understanding of the complexities of designing interventions in persistently unstable zones. Below, we explore several key themes that emerged during our project, namely resilience and coping mechanisms, the significance of 'adaptive ponds of stability,' the importance of building local capacities, the necessity of adaptability, and implications for future action-oriented research in crisis regions.

6.1 Resilience in Crisis: Building Coping Mechanisms through Community Engagement

The resilience potential demonstrated by the communities in the Palestinian refugee camps aligns with themes in existing research on sustainability and resilience in crisis contexts [15, 18, 35]. In line with 'tech public of erosion', we see the computer clubs as entities that must continuously adapt to resource erosion, socio-political challenges, and infrastructural gaps, reflecting resilience as an ongoing negotiation rather than a final outcome. The clubs became publics within the camp environment where technical and soft skills, social cohesion, and temporary stability could emerge. Participants' accounts revealed that these clubs acted as adaptive

refuges, spaces that provided coping mechanisms and meaningful respite within the otherwise unstable camp environment.

By examining the cycles of creation, operation, and dissolution of such ponds, we have developed a nuanced understanding of the fragile balance between external support and local agency in conflict zones. By shifting the focus from immediate relief to capacity-building, our findings highlight the importance of understanding and addressing the ongoing socio-political dynamics in the West Bank of the OPT. This approach resonates with the principles of sustainable HCI, advocating for solutions that empower local communities and contribute to building long-term resilience [4, 8, 31, 51].

However, unlike resilience efforts in contexts marked by spontaneous crises, the entrenched nature of the Palestinian conflict demands a deeply embedded approach, one that addresses socio-political complexities in ways the traditional resilience literature often overlooks. The computer clubs, though temporary and not achieving sustainability, demonstrate the potential for resilience within this system through the community's ongoing efforts to adapt and sustain the clubs despite external pressures. This also reflects findings from Boulus-Rødje et al. [13] on the inherent socio-political entanglements in technical interventions within conflict zones, underscoring how political dynamics can both enable and inhibit resilience efforts. Am'ari's partial success underlines the importance of such managed spaces, where resilience is cultivated through active community efforts and shows how crucial community-building and aligning stakeholders are for sustaining adaptive stability. In this sense, volunteers adapted to personal crises, offering solidarity and emotional support when a participant faced a personal tragedy. This illustrates how the clubs could offer both learning and emotional relief in times of trauma. Conversely, in Jalazone, where partnerships were less robust, the initiative faltered, illustrating the fragility of these adaptive spaces within the 'tech public of erosion'. This further aligns with Meurer et al [35] and Simpson [51], who emphasize the importance of social infrastructure and capital in sustainable ICT interventions.

While the 'tech public of erosion' concept [12] aptly describes the broader context of infrastructural instability in the camps, the concept of 'adaptive ponds of stability' deepens this framework by examining how resilience is actively maintained, albeit temporarily, through individual dedication and managed effort. Unlike the broader erosion that challenges infrastructural continuity, adaptive ponds of stability hinge on agency: the conscious, sustained efforts of volunteers and community members to bring consistency and create conditions of temporary stability. In this way, the ponds are not merely passive spaces but managed resources that reflect both the potential and the limitations of localized resilience efforts in conflict-affected areas. This perspective underscores human agency in the face of systemic instability, differentiating it from the unintentional, ambient erosion described in the broader tech public framework. Further, aligning with Sharma et al. [50], our approach to designing 'adaptive ponds of stability' reflects post-growth principles by promoting sustainable resilience in resource-constrained environments. Rather than aiming for expansive scalability, we focus on meeting immediate, community-defined needs, fostering a model of resilience grounded in local engagement and capacity-building. This post-growth perspective reinforces our findings that resilience within these clubs thrives when designed around the community's own goals and resources, offering a counter-narrative to traditional growth-focused HCI interventions. In parallel to Karusala et al. [27], the adaptive 'ponds of stability' fostered by our computer clubs in Palestinian camps can be seen as collective spaces where resilience emerges not solely from individual adaptability but from community and structural assets. Karusala et al. [27] highlight that assets like social ties and institutional support are often unevenly distributed, complicating the sustainability of resilience efforts. Similarly, Vyas and Dillahunt's strength-based approach with low SES communities reveals resilience as a social, care-oriented process deeply rooted in shared resources and social networks [62]. This approach, which emphasizes community strengths over individual deficits, complements our findings by illustrating that community assets, such as volunteer commitment and local partnerships, support these adaptive spaces but remain vulnerable to uneven resource distribution and stakeholder burnout.

Our findings advocate for a paradigm shift toward resilience, recognizing the inherent limitations of pursuing sustainability in difficult conditions. The repeated breakdowns underscore the infeasibility of achieving sustainability, but the community and capacity-building aspects, along with the temporary stability provided by the computer clubs, suggest reasons to persist despite future interruptions. However, it is important to acknowledge that true resilience was not fully realized; instead, the system showed signs of potential resilience, as evidenced by the repeated attempts to rebuild the clubs. This deeper insight into the resilience-building process, from initial implementation to eventual cessation, enriches the existing literature by illustrating the complex dynamics at play in such interventions. An approach that raises the potential for resilience emphasizes interventions that are both responsive and deeply rooted in the local context [6, 7], addressing the socio-political complexities unique to prolonged crises like the Palestinian conflict. This focus on resilience underscores the importance of adaptable, short-term goals that contribute to long-term resilience in socio-politically unstable environments.

6.2 The Role of 'Adaptive Ponds of Stability' in Fostering Resilience

The sensitizing concept of 'adaptive ponds of stability' encapsulates the essence of the computer clubs as temporary yet impactful adaptive spaces in the refugee camps. The clubs provided settings essential for learning and personal growth, allowing participants to momentarily escape external challenges and engage in supportive and playful learning environments that fostered short-term stability and empowerment. Through the lens of 'tech public of erosion', the clubs can also be seen to embody publics where transient stability emerges not from permanence but from the continual adaptation to shifting resources and political pressures [12]. This resonates with resilience frameworks in the crisis informatics literature, where adaptability and coping mechanisms are seen as key to fostering resilience within social systems [9]. By enabling participants to develop skills and engage in supportive social interactions, the clubs empowered individuals and fostered both individual and community resilience, even though this resilience remained constrained by broader socio-political instability. This aligns with the notion

of design and decline within emerging infrastructures, where interventions must balance building up with the reality of potential breakdowns[53]. The clubs' adaptive stability, despite limited infrastructure and resource depletion, shows how even temporary, localized interventions can foster resilience, enhancing participants' ability to cope with the persistent external pressures in their environment.

By equipping participants with digital literacy and problem-solving skills, initiatives like computer clubs can empower individuals to become agents of change within their communities. The skills and experience gained can lead to innovative solutions and economic opportunities, as evidenced by participants starting their own technology-related ventures, planning on going to university or engaging in further teaching projects. While the direct connection between the program and subsequent impacts could not be definitively established, it suggests potential influence. Examples include children developing an interest in pursuing higher education in informatics, while volunteers applied the skills they gained in the computer club to later lead workshops, engage in business opportunities, and pursue entrepreneurial ventures. Lorenz [31] highlighted the adaptive and coping capacities of social systems, and our findings resonate with this by showing how the clubs enabled participants to develop resilience. Understanding the dynamics of these ponds adds to the literature by showing how even temporary, localized interventions can have ripple effects that extend beyond their immediate impact, fostering both individual and community resilience in subtle, yet significant ways. The clubs' ability to provide temporary stability and foster personal and community development aligns with the transformative potential of community-based interventions discussed by Arnall [7] and Young and Ismail [71]. Despite their transient nature, these "ponds" emphasize the need for resilience-focused approaches to maintain beneficial environments amidst recurring disruptions. By creating a space where participants can develop new skills and strengthen social connections, even temporary interventions can lead to positive and, at times, lasting impacts.

While deeply rooted in the socio-political and cultural contexts of the studied camps, the 'adaptive ponds of stability' framework holds potential for broader application in other conflict-affected regions. The concept's flexibility as a sensitizing tool allows it to adapt to varying local conditions, emphasizing the necessity of tailoring interventions to the specific needs and dynamics of different communities. Successes observed in Am'ari, driven by strong community-building and stakeholder alignment, highlight principles that could inform similar initiatives elsewhere. Conversely, challenges in Jalazone underscore the importance of investing in robust social infrastructure with an alignment of all stakeholders to support such interventions. These insights suggest that scaling up the model would require not only an understanding of local socio-political dynamics but also a commitment to fostering meaningful, collaborative partnerships. As such, the framework provides a replicable foundation for resilience-building, particularly in settings where instability persists, provided its implementation is grounded in local agency and adaptable design.

6.3 Building Local Capacities and Social Capital for Resilience

Enhancing local capacities and fostering social capital was essential in developing the clubs as adaptive spaces within the refugee camps. The 'tech public of erosion' framework highlights how socio-technical initiatives in conflict zones need to integrate local capacities to withstand the persistent erosion of resources and infrastructures. By fostering agency and collaboration among local stakeholders, our project adhered to holistic intervention principles that advocate for comprehensive, context-sensitive strategies [17]. It particularly aligned with broader resilience-building principles by recognizing that enduring socio-political dynamics in conflict-affected regions like Palestine require solutions that empower communities to act autonomously within external constraints [9, 12, 13, 53].

A multi-stakeholder engagement, including local community members, university partners, and international researchers, was vital in establishing a resilient support network capable of sustaining the project. Work by Bjørn and Boulus-Rødje [9] on 'infrastructural inaccessibility' among tech entrepreneurs in Palestine emphasized the need to engage local agents to create socio-technical systems that navigate restricted infrastructures and political boundaries. Without this collaboration, initiatives will struggle to progress, as evidenced by Jalazone's failure to sustain the club due to a lack of robust social infrastructure. The club's success in Am'ari, on the other hand, demonstrates how social capital and local collaboration can enhance resilience in the face of persistent disruptions, echoing insights from sustainable ICT interventions that emphasize community engagement and local agency [8, 15, 18, 23, 51].

The project, through its repeated failures (mainly the recurrent closures of the computer clubs) and small successes (referred to here as adaptive ponds of stability), demonstrated that building social capital within the community can create a more supportive environment, enhancing the resilience of both the community and the project itself. Episodes of active engagement and empowerment of community members led to a sense of ownership and responsibility. This focus on capacity building for long-term impact was evident as local participants gained not only technical skills but also leadership and collaboration abilities. Volunteers reflected on how their involvement broadened their understanding of and beyond computer science, while children developed key interpersonal skills, such as cooperation and self-presentation, all contributing to their personal growth and resilience. The clubs had a significant impact on both skill development and social integration. Moreover, the clubs inspired children to explore new educational possibilities. Volunteers, initially in support roles, progressively took on leadership responsibilities, organizing workshops and applying their newly acquired skills in professional ventures. This shift from volunteer facilitators to leaders highlights the transformative power of the clubs in nurturing not only technical skills but also personal development, community cohesion, and a sense of ownership. This can also be seen to align with the dimensions of sustainability discussed by Ali and Bailur [4], particularly the social aspects that emphasize engaging local communities and ensuring that interventions and their outcomes remain relevant to them.

6.4 Adapting with Humility

As the project evolved, the need for adaptability became ever more evident, with the computer clubs transforming from a peace-building initiative into 'adaptive ponds of stability'. This transition from persuasive to practice-oriented design highlights the necessity of listening to and adapting to community needs rather than imposing predetermined solutions. It also illustrates how humility in research and design requires being willing to adapt goals to community realities, once again resonating with the concept of 'tech public of erosion' [12]. Our experience reinforces the value of creating spaces that offer respite and normalcy, even if they do not resolve underlying conflicts. It also supports the existing literature by showing that improvisation, responsiveness to on-the-ground realities, and flexible, adaptable technology are vital for the longevity and impact of development projects [4]. The importance of improvisation emerged as the clubs adapted to children's shifting priorities, with an increased focus on social interaction and community building, as evidenced by the volunteers' observations of children becoming more social and forming friendships. This adaptive approach is a direct reflection of the humility required to embrace adaptive ponds of stability as a satisfactory outcome of interventions, regardless of any original, more ambitious goals.

In view of the above, we argue here for the significance of humility in HCI research and design, recognizing that technology's impact often deviates from initial visions. The concept of ponds itself embodies this humility, acknowledging that in the face of overwhelming challenges, even small, temporary successes are valuable. By linking humility to the recognition and nurturing of these ponds, our research adds a new dimension to the discourse on sustainable and resilient ICT interventions, emphasizing that humility is not just a methodological stance but a practical necessity in the face of complex, evolving crises. The project's shift from fostering peace in a conflict-ridden region to a more grounded, community-focused initiative underscores this need for humility. It also reflects a willingness to embrace humble research and design objectives, emphasizing the value of working with, rather than for, communities. As HCI increasingly embraces user-centered approaches, our findings highlight the necessity for researchers and designers to understand users' needs, perspectives, and contexts rather than imposing their own assumptions. This approach aligns with Vindevogel [61], who stresses the importance of understanding local contexts and fostering collaborative, empathetic relationships with community members.

The 'tech public of erosion' framework emphasizes that communities in conflict-affected areas develop resilience by continually adapting to erosion, responding not with rigid solutions but with flexibility and responsiveness. The computer clubs became not just sites of technology and learning but spaces of respite and collective engagement, where both participants and volunteers learned to navigate political and social barriers. This adaptive stability, framed by humility, challenges the "white savior" narrative that can inadvertently shape HCI interventions in marginalized communities. By centering humility and genuine collaboration, we seek to challenge these problematic dynamics, aiming for respectful, context-aware, and beneficial interventions. Our experience emphasizes that designers and researchers should listen, adapt, and respond to the communities they serve. It highlights the value of creating spaces, such as ponds, that, while not solving all problems, offer respite from chaos and provide opportunities for learning, enjoyment, and ease.

The lessons from our project prompt a deeper reflection on the roles of researchers and designers. They call for a commitment to humility, adaptability, and collaboration, ensuring that interventions are not only effective but also genuinely beneficial for the communities they aim to serve. This includes rethinking goals such as 'empowering the community', which can imply that researchers or designers hold the power to bestow. Instead, we argue that the focus should be on fostering genuine, equitable, and respectful partnerships. By consciously addressing the pitfalls of white saviorism, we can create more balanced and respectful collaborations in global HCI efforts.

The notion of setting up a technology hub in an area fraught with political instability and deep-seated conflict may appear, in hindsight, as optimistic and naive. The underlying assumption was that such an initiative could bridge divides and serve as a beacon of peace. Yet, the complexity of conflicts in regions like the OPT demands a more nuanced approach. The naive ambition of peacemaking underestimated the socio-political challenges.

This experience shows that success lies not in lofty, imposed goals but in practical, immediate responses to local needs. The clubs, though temporary, illustrate a practice-oriented design philosophy that underscores adaptability and humility as essential for sustainable HCI. By linking humility with resilience, our research suggests that designers and researchers should listen and adapt, embracing adaptive successes like ponds that arise organically through community collaboration and agency.

Our experience also reflects the perspective of sustainability as a delicate balance between stability and change [19], supporting dynamic approaches that accommodate impermanence and transition. This further emphasizes the need for flexible, user-centered design methodologies in conflict-affected regions. The adaptability demonstrated in our project is consistent with the broader literature on crisis informatics and resilience [23]. Our ability to pivot the project's focus in response to the community's evolving needs reflects this principle. For instance, managing hierarchical issues among volunteers or redesigning room layouts and session structures, which required critical adaptations to keep the club running smoothly. However, adaptability was not always feasible due to underlying structural factors. Social or political assumptions, for example, limited our ability to reach a more diverse range of participating children. Additionally, a donor economy mindset that favors new partnerships over continuing existing projects further hindered sustained adaptability.

Drawing from the above discussion, we offer several key recommendations for HCI researchers and activists engaged in similar initiatives:

1. Prioritize Resilience Over Sustainability: In conflict zones, where long-term sustainability is often unachievable, interventions should focus on creating temporary yet meaningful ponds that provide relief and support. These are spaces where participants can experience moments of normalcy, ease, joy, and constructive engagement.

2. Engage in Collaborative and Culturally Sensitive Practices: Deep collaboration with local communities is essential. Co-creating interventions respectful of local norms, values, and practices ensures relevance and acceptance, fostering a sense of ownership and relevance among community members. This approach also helps to mitigate the risks of imposing external solutions that may not align with local needs or be perceived as culturally insensitive.

3. Embrace Flexibility and Adaptability: Given the unpredictable nature of conflict environments, interventions must be capable of adapting to changing circumstances and emerging needs. Flexibility also extends to the researchers involved, who must be prepared to modify their roles and expectations as the situation evolves.

4. Build Strong, Localized Partnerships: Strong local partnerships are vital for navigating the complexities of conflict zones. Collaborating with local organizations, community leaders, and stakeholders is crucial for gaining insights into the community's needs, navigating complex social and political landscapes, and ensuring the intervention's cultural and practical relevance. These partnerships anchor the intervention within the community, supporting its continuity and effectiveness.

5. Focus on Capacity Building for Long-Term Impact: Empowering local participants with the skills and knowledge to sustain and adapt interventions ensures that the benefits extend beyond the project's duration. Capacity building should include not only technical skills related to the intervention but also leadership, project management, and problem-solving abilities.

6. Approach with Humility and Realistic Expectations: Interventions should be approached with humility, recognizing the limitations of external actors and the complexity of the local context. Researchers and activists must avoid the "white savior" mentality; instead, they should support local efforts. Setting realistic expectations and valuing incremental successes is key to building trust and fostering genuine collaboration.

7. Integrate Reflexive and Ethical Practices: Ongoing reflexive practices are crucial for ensuring that interventions are ethically sound and culturally sensitive, prioritizing community well-being. This involves being aware of power dynamics, potential biases, and the impact of the intervention on the local community.

7 Limitations

The intermittent operation of the computer clubs, marked by periods of inactivity, limited our ability to assess their long-term impact on participants and community resilience. While the use of qualitative methods provided valuable, in-depth insights, these are highly context-specific, making it difficult to fully capture the broader socio-political dynamics influencing the clubs. Additionally, as external researchers, our reliance on local gatekeepers for access may have influenced our interactions and the data collected, potentially leaving certain aspects of the clubs' impact underexplored.

8 Conclusion

This paper has explored the complexities of establishing two computer clubs in the West Bank of the OPT, shedding light on the unique challenges and unexpected outcomes of implementing socio-technical interventions in conflict-affected regions. Initially, our goals focused on achieving sustainability and contributing to peacebuilding efforts. However, the harsh realities of prolonged instability required a shift in focus toward fostering resilience and adaptability within a 'tech public of erosion' [12].

Our study contributes to the broader field of HCI by providing a detailed case study of implementing technology-driven initiatives in politically unstable environments. The sensitizing concept 'adaptive ponds of stability' offers a new lens for understanding the nature of temporary, impactful spaces formed through community-driven engagement and adaptive resilience. Unlike static safe havens, these ponds rely on the continuous agency, dedication, and adaptability of local volunteers and participants to exist and flourish, even in challenging circumstances. They are not defined by their permanence but by their capacity to provide relief and empowerment amid persistent instability. This concept enriches the ICT4D and crisis informatics discourse by underscoring how resilience, adaptability, and local agency emerge as primary pillars over traditional notions of sustainability. For HCI professionals, this study highlights the critical importance of humility and community involvement when designing interventions in conflict-affected areas. Rather than aiming for lasting structures, our findings advocate for designing interventions that can flexibly adapt and reconfigure, empowering communities to navigate and respond to cycles of disruption. This approach calls for a more empathetic and context-sensitive approach to supporting communities in long-lasting crises [46].

In sum, the 'adaptive ponds of stability' sensitizing concept extends beyond the concept of 'tech public of erosion' [12] by introducing a framework for understanding managed resilience in conflict-affected areas. It provides a flexible yet structured framework to examine how temporary, meaningful spaces of stability emerge and adapt through community-driven efforts. This framing complements 'tech public of erosion' by illuminating the proactive, human-centered processes that sustain resilience, even within highly volatile contexts. By focusing on the intentional actions and adaptive capacities of local communities, the concept deepens our understanding of resilience as a dynamic, agent-driven process rather than a static outcome. This perspective underscores the importance of fostering local agency, capacity-building, adaptability, and support for those who maintain these adaptive spaces against the backdrop of constant erosion in designing socio-technical interventions for conflict-affected settings.

References

[1] Konstantin Aal. 2024. *Influence of Social Media in a Changing Landscape of Crisis: Insights into the Digital Dynamics of Conflict and Activism in the Middle Eastern and North African Region.* Springer Nature.

[2] Konstantin Aal, Marios Mouratidis, Anne Weibert, and Volker Wulf. 2016. Challenges of CI initiatives in a political unstable situation-case study of a computer club in a refugee camp. In *Proceedings of the 2016 ACM International Conference on Supporting Group Work*. 409–412.

[3] Konstantin Aal, George Yerousis, Kai Schubert, Dominik Hornung, Oliver Stickel, and Volker Wulf. 2014. Come_in@ palestine: adapting a german computer club concept to a palestinian refugee camp. In *Proceedings of the 5th ACM international conference on Collaboration across boundaries: culture, distance & technology*. 111–120.

[4] Maryam Ali and Savita Bailur. 2007. The challenge of "sustainability" in ICT4D—Is bricolage the answer. In *Proceedings of the 9th international conference on social implications of computers in developing countries*, Vol. 29. Citeseer, 54–60.

[5] Helen T Allan. 2006. Using participant observation to immerse oneself in the field: The relevance and importance of ethnography for illuminating the role of emotions in nursing practice. *Journal of Research in Nursing* 11, 5 (2006), 397–407.

[6] Walid Ammar, Ola Kdouh, Rawan Hammoud, Randa Hamadeh, Hilda Harb, Zeina Ammar, Rifat Atun, David Christiani, and Pierre A Zalloua. 2016. Health system resilience: Lebanon and the Syrian refugee crisis. *Journal of global health* 6, 2 (2016).

[7] Alex Arnall. 2015. Resilience as transformative capacity: Exploring the quadripartite cycle of structuration in a Mozambican resettlement programme. *Geoforum* 66 (2015), 26–36.

[8] Muluneh Atinaf, Salehu Anteneh, and Mesfin Kifle. 2023. A holistic understanding of information and communication technology for development through context, resilience, and sustainability: Evidence from a local agriculture extension information service in Ethiopia. *The Electronic Journal of Information Systems in Developing Countries* 89, 4 (2023), e12260.

[9] Pernille Bjørn and Nina Boulus-Rødje. 2018. Infrastructural inaccessibility: Tech entrepreneurs in occupied palestine. *ACM Transactions on Computer-Human Interaction (TOCHI)* 25, 5 (2018), 1–31.

[10] Herbert Blumer. 1954. What is Wrong with Social Theory? *American Sociological Review* 19, 1 (1954), 3–10. http://www.jstor.org/stable/2088165

[11] Nina Boulus-Rødje. 2018. Stuck with my body at Qalandiya checkpoint: Reflections upon conducting fieldwork in an uncertain field site. In *SAGE Research Methods Cases: Part 2*. SAGE Publications.

[12] Nina Boulus-Rødje and Pernille Bjørn. 2021. Tech public of Erosion: the formation and transformation of the Palestinian tech entrepreneurial public. *Computer Supported Cooperative Work (CSCW)* (2021), 1–41.

[13] Nina Boulus-Rødje, Pernille Bjørn, and Ahmad Ghazawneh. 2015. "It's about business not politics": Software development between Palestinians and Israelis. In *ECSCW 2015: Proceedings of the 14th European Conference on Computer Supported Cooperative Work, 19-23 September 2015, Oslo, Norway*. Springer, 43–61.

[14] Glenn A Bowen. 2020. *Sensitizing concepts*. SAGE Publications Limited London, UK.

[15] Aaron R Brough, Grant E Donnelly, Vladas Griskevicius, Ezra M Markowitz, Kaitlin T Raimi, Crystal Reeck, Remi Trudel, Kurt B Waldman, Karen Page Winterich, and Kimberly S Wolske. 2020. Understanding how sustainability initiatives fail: A framework to aid design of effective interventions. *Social Marketing Quarterly* 26, 4 (2020), 309–324.

[16] Albane Buriel. 2020. Education in humanitarian emergencies: Artistic response through the artistic biography with young people in Iraq and Syria. In *The 1st SSASEA-UNESCO Virtual conference arts education*.

[17] Lorenzo Chelleri, James J Waters, Marta Olazabal, and Guido Minucci. 2015. Resilience trade-offs: addressing multiple scales and temporal aspects of urban resilience. *Environment and Urbanization* 27, 1 (2015), 181–198.

[18] FE Etta and S Parvyn-Wamahiu. 2003. Vol. 2: The experience with community telecenters. *Dakar (etc.): Codesria (etc.)* (2003).

[19] A Fowler. 2013. The virtuous spiral: A guide to sustainability for NGOs in international development.

[20] Ricardo Gomez and Benjamin Casadiego. 2002. Letter to Aunt Ofelia: Seven proposals for human development using new information and communication technologies. *Regional Development Dialogue* 23, 2; SEAS AUT (2002), 1–14.

[21] Xinning Gui, Yuhan Luo, Xianghua Ding, Saeed Abdullah, Emma Dixon, and Shaowen Bardzell. 2023. Designing for and Reflecting upon Resilience in Health and Wellbeing. In *Companion Publication of the 2023 ACM Designing Interactive Systems Conference*. 135–137.

[22] Roger W Harris, A Kumar, and V Balaji. 2003. Sustainable telecentres? Two cases from India. *The digital challenge: Information technology in the development context* 8 (2003), 124–135.

[23] Richard Heeks and Angelica V Ospina. 2019. Conceptualising the link between information systems and resilience: A developing country field study. *Information Systems Journal* 29, 1 (2019), 70–96.

[24] SA Jacob and SP Furgerson. 2012. Writing interview protocols and conduction interviews: Tips for students new to the field of qualitative research, 17, 1-10.

[25] Tiina Järvi. 2024. Beyond refugeeness: complex subjectivities in Palestinian refugee camps. *Social & Cultural Geography* (2024), 1–19.

[26] Yasmin Kafai, Kylie Peppler, and Robbin Chapman. 2009. *The computer clubhouse: A place for youth*. Oxford University Press.

[27] Naveena Karusala, Isaac Holeman, and Richard Anderson. 2019. Engaging identity, assets, and constraints in designing for resilience. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (2019), 1–23.

[28] Stephen Kemmis, Robin McTaggart, and Rhonda Nixon. 2014. The action research planner: Doing critical participatory action research.

[29] Hillary Kipruto, Derrick Muneene, Benson Droti, Violet Jepchumba, Chukwudi Joseph Okeibunor, Juliet Nabyonga-Orem, and Humphrey Cyprian Karamagi. 2022. Use of digital health interventions in sub-saharan africa for health systems strengthening over the last 10 years: a scoping review protocol. *Frontiers in Digital Health* 4 (2022), 874251.

[30] Rajendra Kumar and Michael L Best. 2006. Impact and sustainability of e-government services in developing countries: Lessons learned from Tamil Nadu, India. *The Information Society* 22, 1 (2006), 1–12.

[31] Daniel F Lorenz. 2013. The diversity of resilience: contributions from a social science perspective. *Natural hazards* 67, 1 (2013), 7–24.

[32] Judith Mair, Brent W Ritchie, and Gabby Walters. 2016. Towards a research agenda for post-disaster and post-crisis recovery strategies for tourist destinations: A narrative review. *Current issues in tourism* 19, 1 (2016), 1–26.

[33] Emanuel Marx. 1992. Palestinian refugee camps in the West Bank and the Gaza Strip. *Middle Eastern Studies* 28, 2 (1992), 281–294.

[34] Nour Mattour and Souad Kamoun-Chouk. 2024. Circular Economy Challenges and Opportunities amidst Sustainable Development and Perpetual Crises: A Reflection from the Learning Lens of Palestinian Universities. *Circular Economy and Sustainability* (2024), 1–19.

[35] Johanna Meurer, Claudia Müller, Carla Simone, Ina Wagner, and Volker Wulf. 2018. Designing for sustainability: Key issues of ICT projects for ageing at home. *Computer Supported Cooperative Work (CSCW)* 27 (2018), 495–537.

[36] Marios Mouratidis. 2019. Why ethnography matters–the case of a Palestinian Refugee Camp. *With an Eye to the Future: HCI Research and Practice in the Arab World (Glasgow, United Kingdom* (2019).

[37] Marios Mouratidis, Sarah Rüller, Konstantin Aal, Shaimaa Lazem, Anicia Peters, Nina Boulus-Rødje, Simon Holdermann, Vasilis Vlachokyriakos, Ann Light, Dave Randall, et al. 2021. Coping with Messiness in Ethnography: Authority, Bias and Immersion in ethnographic Fieldwork in the non-Western World. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–5.

[38] OCHA oPT. 2019. *Humanitarian Impact of Settlements*. https://www.ochaopt.org/theme/humanitarian-impact-of-settlements

[39] Komathi Perialathan, Mohammad Zabri Johari, Norrafizah Jaafar, Kong Yuke Lin, Low Lee Lan, Nur Aliyah Sodri, and Siti Nur Nabilah Mohd Yunus. 2021. Enhanced primary health care intervention: perceived sustainability and challenges among implementers. *Journal of Primary Care & Community Health* 12 (2021), 21501327211014096.

[40] Francisco J Proenza. 2001. Telecenter sustainability: Myths and opportunities. *Journal of Development Communication* 12, 2 (2001), 94–109.

[41] United Nations Relief and Works Agency for Palestine Refugees in the Near East. 2016. UNRWA 2016.

[42] Mitchel Resnick, Yasmin Kafai, John Maeda, Natalie Rusk, and J Maloney. 2003. A networked, media-rich programming environment to enhance technological fluency at after-school centers in economically-disadvantaged communities. *Proposal to National Science Foundation* (2003).

[43] Mitchel Resnick and Natalie Rusk. 1999. 11. the computer clubhouse: Technological fluency in the inner city. *High technology and low-income communities: prospects for the positive use of advanced information technology* 54 (1999).

[44] Christian Reuter and Marc-André Kaufhold. 2018. Fifteen years of social media in emergencies: a retrospective review and future directions for crisis informatics. *Journal of contingencies and crisis management* 26, 1 (2018), 41–57.

[45] Dave Randall and Mark Rouncefield. 2005. Ethnography. In *Encyclopedia of Human Computer Interaction*. The Interaction Design Foundation.

[46] Sarah Rüller, Konstantin Aal, Norah Abokhodair, Houda Elmimouni, Yarden Skop, Dave Randall, Nina Boulus-Rodje, Alan Borning, and Volker Wulf. 2024. Ethnography at the Edge: Exploring Research Dynamics in Crisis and Conflict Areas. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems*. 1–4.

[47] Sarah Rüller, Konstantin Aal, Marios Mouratidis, and Volker Wulf. 2020. Messy Fieldwork: A Natural Necessity or a Result of Western Origins and Perspectives?. In *Companion Publication of the 2020 ACM Designing Interactive Systems Conference*. 185–190.

[48] Natalie Rusk, Mitchel Resnick, Stina Cooke, et al. 2009. Origins and guiding principles of the computer clubhouse. *The computer clubhouse: Constructionism and creativity in youth communities* (2009), 17–25.

[49] Hilmi S Salem. 2019. Agriculture Status and Women's Role in Agriculture Production and Rural Transformation in the Occupied Palestinian Territories. *Journal of Agriculture and Crops* 5, 8 (2019), 132–150.

[50] Vishal Sharma, Neha Kumar, and Bonnie Nardi. 2023. Post-growth Human–Computer Interaction. *ACM Transactions on Computer-Human Interaction* 31, 1 (2023), 1–37.

[51] Lyn E Simpson. 2005. Community informatics and sustainability: Why social capital matters. *The Journal of Community Informatics* 1, 2 (2005).

[52] Sandeep Kumar Sood and Keshav Singh Rawat. 2021. A scientometric analysis of ICT-assisted disaster management. *Natural hazards* 106, 3 (2021), 2863–2881.

[53] Stephanie B Steinhardt. 2016. Breaking down while building up: design and decline in emerging infrastructures. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. 2198–2208.

[54] Gunnar Stevens, Michael Veith, and Volker Wulf. 2005. Bridging among ethnic communities by cross-cultural communities of practice. In *Communities and Technologies 2005: Proceedings of the Second Communities and Technologies Conference, Milano 2005*. Springer, 377–396.

[55] Oliver Stickel, Dominik Hornung, Konstantin Aal, Markus Rohde, and Volker Wulf. 2015. 3D Printing with marginalized children—an exploration in a Palestinian refugee camp. In *ECSCW 2015: Proceedings of the 14th European Conference on Computer Supported Cooperative Work, 19-23 September 2015, Oslo, Norway*. Springer, 83–102.

[56] Milan Stute, Max Maass, Tom Schons, Marc-André Kaufhold, Christian Reuter, and Matthias Hollick. 2020. Empirical insights for designing information and communication technology for international disaster response. *International journal of disaster risk reduction* 47 (2020), 101598.

[57] Barbara Tedlock. 1991. From participant observation to the observation of participation: The emergence of narrative ethnography. *Journal of anthropological research* 47, 1 (1991), 69–94.

[58] David R Thomas. 2006. A general inductive approach for analyzing qualitative evaluation data. *American journal of evaluation* 27, 2 (2006), 237–246.

[59] Mohammad Mahdi Vali-Siar and Emad Roghanian. 2022. Sustainable, resilient and responsive mixed supply chain network design under hybrid uncertainty with considering COVID-19 pandemic disruption. *Sustainable production and consumption* 30 (2022), 278–300.

[60] Michael Veith, Kai Schubert, and Volker Wulf. 2007. come_IN: Identity and role affiliation mediated by an inter-cultural computer club. In *Proceedings of the IADIS International Conference e-Society*, Vol. 3. 2007.

[61] Sofie Vindevogel. 2017. Resilience in the context of war: A critical analysis of contemporary conceptions and interventions to promote resilience among war-affected children and their surroundings. *Peace and conflict: journal of peace psychology* 23, 1 (2017), 76.

[62] Dhaval Vyas and Tawanna Dillahunt. 2017. Everyday resilience: Supporting resilient strategies among low socioeconomic status communities. *Proceedings of the ACM on Human-Computer Interaction* 1, CSCW (2017), 1–21.

[63] Brian Walker, Crawford S Holling, Stephen R Carpenter, and Ann Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. *Ecology and society* 9, 2 (2004).

[64] Human Rights Watch. 2023. Israel: Collective Punishment against Palestinians. https://www.hrw.org/news/2023/02/02/israel-collective-punishment-against-palestinians

[65] Anne Weibert, Matthias Korn, Thomas von Rekowski, and Kai Schubert. 2009. How come_IN computer clubs may foster collaboration in an intercultural neighborhood. In *Workshop on Culture and Technologies for Social Interaction at INTERACT 2009*.

[66] Anne Weibert, Marios Mouratidis, Renad Khateb, Sarah Rüller, Miriam Hosak, Shpresa Potka, Konstantin Aal, and Volker Wulf. 2017. Creating environmental awareness with upcycling making activities: A study of children in Germany and Palestine. In *Proceedings of the 2017 conference on interaction design and children*. 286–291.

[67] A Weibert and V Wulf. 2010. All of a sudden we had this dialogue. *Intercultural computer clubs' contribution to sustainable integration* (2010).

[68] Nicholas H Wolfinger. 2002. On writing fieldnotes: collection strategies and background expectancies. *Qualitative research* 2, 1 (2002), 85–93.

[69] Volker Wulf, Volkmar Pipek, David Randall, Markus Rohde, Kjeld Schmidt, and Gunnar Stevens. 2018. *Socio-informatics*. Oxford University Press.

[70] George Yerousis, Konstantin Aal, Thomas Von Rekowski, David W Randall, Markus Rohde, and Volker Wulf. 2015. Computer-enabled project spaces: Connecting with Palestinian refugees across camp boundaries. In *Proceedings of the 33rd annual ACM conference on human factors in computing systems*.

[71] Helen Young and Musa Adam Ismail. 2019. Complexity, continuity and change: livelihood resilience in the Darfur region of Sudan. *Disasters* 43 (2019), S318–S344.