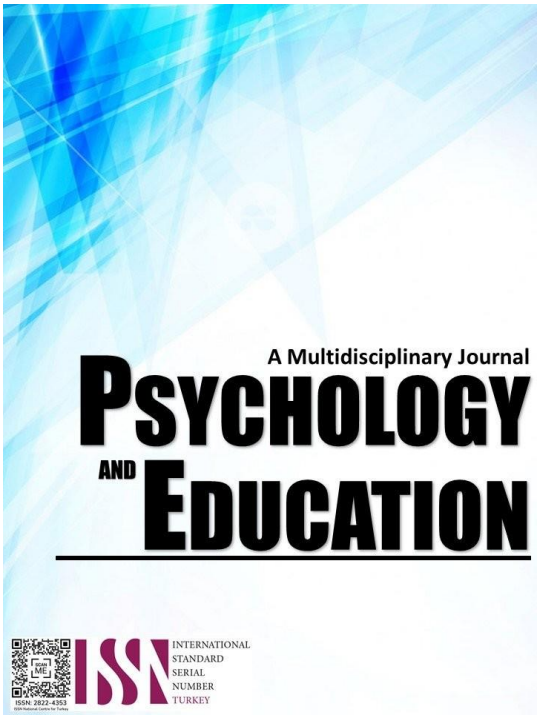
TECHNOLOGY-ENABLED PUBLIC PARTICIPATION: OPPORTUNITIES AND CHALLENGES OF PARTICIPATORY RESEARCH



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Research Article

Technology-Enabled Public Participation: Opportunities and Challenges of Participatory Research

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Abstract

This study explores the dynamics of community participation by examining the shift from conventional to digital technology-powered processes. Internet-based platforms promise advanced and comprehensive procedures. However, the paradox remains in its way of mentioning the digital divide, privacy issues, and bias of algorithms and machine learning (ML) that demands an afterthought. This paper examines the advantages of online technologies to liberalize community engagements, level up information gathering and interpretations, encourage cooperation and networks, and capitalize on real-time responses. It focuses on ethical matters like the protection and safety of the respondents, the bias of the algorithmic system, and power crescendos that require attention and investigation. Conversely, the chapter navigates the emerging practices for comprehensive and sound research practices, particularly in participatory research, by developing trust and openness, cultivating skilled labor, and tackling best practices in the virtual world, AI, and citizen science. Through the narrative review, challenges and opportunities of digital technology tools were carefully explored for community engagements intended to contribute to the advancements of holistic, equitable, and effective community participation methods in policy formulation and decision-making processes.

Keywords: *digital engagement, participatory research, citizen science, data privacy, ethical considerations, digital divide, inclusive research*

Introduction

The development of public participation actions has shifted from traditional approaches such as town halls and public hearings to technology-anchored systems. Traditionally, public authorities utilized the in-person approach to gatherings and data collection for community inputs (Kloby & Sadeghi, 2013). Conversely, these approaches had their constraints, resulting in new approaches. The emerging Web 2.0 and other applications have changed public engagement, empowering them to be more active and accessible exchanges among public offices and the community (Kloby & Sadeghi, 2013; Al Araby, 2024). This technological advancement led to the expansion of the electronic governance paradigms where the community is perceived as an active individual rather than a submissive recipient of government assistance and services (Al Araby, 2024). While online transactions promise increased access and engagement among community members, they also consist of challenges like the digital divide and technological economics (Longo, 2017; Rowe & Gammack, 2004). As the public authorities are experimenting with these new ways, it is imperative to conduct studies on the success of electronic-based participation systems (Longo, 2017; Rowe & Gammack, 2004).

Conversely, conventional research approaches are always labeled with constraints in coming up with multiple subjects and perspectives that can end up with barriers to accessing information that might eliminate certain groups. (Nind, 2009). Different and artistic methods like music, painting, or social media can address these issues by developing a non-violent space for representation and unsettling authorities (Phillips et al., 2024). Using the online and offline approaches can open more significant opportunities for the public to participate and lessen the sample partialities (Hope, 2016). Computer-aided approaches can leverage participatory research, especially for individuals with handicaps (Seymour, 2001). However, the creative approach has its constraints, such as being time- and resource-based, lacking generalizability, and having ethical issues (Phillips et al., 2024). Investigators should consider the objectives of the study, the nature of the focus group, and the reasonable challenges when selecting an approach. A mixed method may offer the advantages of both leveraging the quantitative data and the qualitative explorations (Phillips et al., 2024).

Recent studies highlight the demand for groundbreaking methods to improve civic participation and democratize science. Researchers encourage reconstruction engagement in this field through instinctive, proactive, and sensible practices (Chilvers & Kearnes, 2020). This can be through shifting from a traditional intentional approach to incorporating different types of people's engagement (Davies, 2019). Communal- based participatory studies and citizen science exude engaging opportunities for connecting the community in policy papers with the promise of amalgamating their strengths (Richardson, 2014). Social science studies collaborations are suggested to liberalize science, empowering the relegated populace to participate in the process and make decisions (Schensul, 2002). These methods contest the elite approaches of policy research and are targeted to mend the difference between the expert's and people's engagement. Nonetheless, applying this groundbreaking method confronts problems, including ethical and force differentiations (Schensul, 2002; Richardson, 2014). According to Desouza and Bhagwatwar (2014), technology-based community participation concerns collaborative platforms that utilize digital applications to let citizens participate in policy development and solutions. These programs can be classified into four prototypes or models grounded on data and expansion approaches (Desouza & Bhagwatwar, 2014). In contrast, though digital technology promises to bridge the engagement challenges, this system also has possible risks that demand further investigation (Rowe & Gammack, 2004). Adopting Web 2.0 and social media applications for community participation confronts organizational, societal, and governance challenges rather than digital ones (McNutt, 2014). These applications have developed from e-government projects to community participation methods that capitalize on social image or brand (McNutt, 2014). Advancements in

digital applications enabled new forms of community participation that involve citizen science programs and unstructured learning opportunities (Scanlon, 2012). As digital technology progresses, it allows the community to participate in scientific discourses and research activities (Scanlon, 2012).

Studies conducted by Schirpke et al. (2023) and Nurminen (2016) posited that a multifaceted range of digital technologies was used to evaluate the ecosystem services and advocate mental well-being programs in the form of social media, mobile applications, virtual augmented reality, data visualization, and internet- based tools. These tools have effectively engaged professionals and laypeople in comprehending the complicated information on the pandemic (DiBenigno et al., 2021). Furthermore, teleconferencing, internet-based interventions, and virtual systems have revealed efficacy, while mobile tools and serious gaming need more studies (Mohr et al., 2013). These new trends in digital applications render optimistically for real-time data, the same experience of the ecosystem, enhanced data collection and interpretation for a better decision-making support system (Nurminen, 2016; Schirpke et al., 2023). Conversely, the arguments remain, including the ethical issues, data access, and the need to improve paradigm and strategy assessments (Schirpke et al., 2023; Mohr et al., 2013).

This section explores the challenges and opportunities that digital technology applications bring in advancing community participation and participatory studies. Furthermore, it will delve into these technologies' ethical concerns and potential biases. Conversely, to determine the emerging best practices and future directions of utilizing technology to develop a more proactive and inclusive public participation.

Framework

This study is anchored with Participatory Femocracy Frameworks that focus on enhancing citizen participation in planning and decision-making through combined elements of direct representation (Aragonès & Sánchez-Pagés, 2005). This paradigm incorporates ICT (Information Communication Technologies to direct e-participation of the community and enhance democratic processes in digital communities (Rudan & Rudan, 2014; Tambouris et al., 2007). The composition of the participatory democracy paradigm contains democratic practices, engagement areas, strategy, and ICT applications (Tambouris et al., 2007). To implement this paradigm, it is important to consider the societal and economic environments, the type and extent of engagement, the scope of digital tools to be employed, and the equilibrium between the government system and the actual engagements of the community (Thakur, 2009). Incorporating these essential components, the participatory democracy paradigm will strengthen community participation in decision and policymaking, advance government performances and services, and foster democratic culture and practices in digital and face-to-face ecosystems (Aragonès & Sánchez- Pagés, 2005; Rudan & Rudan, 2014). Below is the concept visualization of the Participatory Femocracy Framework as proposed by Maming, Escarilla, Taño-an and Flores.

Fig. 1. *Maming, Escarilla, Taño-an & Flores Participatory Femocracy Framework*

The Participatory Femocracy Framework as proposed by Maming, Escarilla, Taño-an & Flores captures the elements such as gender equality, inclusivity, participatory decision and policy making, empowering the poor and marginalized, and intersectionality. Conversely, democratic practices, engagement areas, strategies, and ICT applications, are all interconnected and influenced by societal and economic factors.

Methodology

This research utilized the Narrative Review Method. This approach offers flexible and thorough approaches to summarize knowledge in the medical field and other disciplines (Sukhera, 2022a; Sukhera, 2022b). This approach allows the researchers to comprehensively analyze the literature on the conducted topics, getting beyond simple perspectives or explanations (Sukhera, 2022a). The narrative review method can bring rich, meaningful interpretations of various studies (Sukhera, 2022b). These include the critical and integrative reviews (Sukhera, 2022b) on technology-enabled public engagement specifically the opportunities and challenges of participatory research. Hakala et al. (2020) proposed a model for the narrative review that is rooted in an influential narrative in literature through thematic and rhetorical readings. Jones (2004) maintains that a narrative inductive interpretive approach should be utilized to strengthen narrative reviews using a qualitative approach. Although this method has been criticized for its selectivity, narrative reviews remain valuable for determining general perspective and developing a thorough understanding of the problem (Sukhera, 2022a; Sukhera, 2022b).

Results and Discussion

The Opportunities of Participatory Research

Enhanced Accessibility and Inclusivity

Digital technology has the potential to bridge the gap and advance access to participation for marginalized individuals with disabilities. ICTs (Information and Communication Technologies) can improve societal and economic engagements by paving the way for information, education, and job opportunities (Khetarpal, 2014). Conversely, digital tools pause challenges like digital divides if not properly planned and developed (Foley & Ferri, 2012). Universal design principles can bring value and must be integrated from the inception rather than added later (Blanck, 2008). Remote participation through online conferencing and social media applications can enhance access to worldwide governance processes for those in debility and its advocates (Trevisan & Cogburn, 2020). Digital technologies can enable personalized learning, telecommuting, telemedicine, and other advantages for those in remote areas (Blanck, 2008). To make things inclusive, those in authorities, nongovernment organizations, and private organizations must join forces to eliminate challenges to digital access for individuals with handicaps (Khetarpal, 2014).

Digital tools and mobile applications can bring prospects for remote engagements and data gathering in marginalized communities. Online tools have empowered community participation during the pandemic, enabling participatory research and interference adaptation (Manikam et al., 2021). These tools provide value like lessening travel costs and heightened elasticity for respondents. In the context of development, digital technology can enhance opportunities for education and client experiences even though inequality and worker exploitation still exist (Nicholson et al., 2021). Furthermore, mobile health tools have indicated a system to oversee cervical cancer screening campaigns in a setting that is low in resources, possesses high data quality, and has fewer missing data (Quercia et al., 2017). In consonance, mobile phone-based information data gathering has been effectively utilized to enhance conditional cash transfer systems, cutting costs and refining accuracy in remote places with indigenous people (Schuster & Brito, 2011).

Diversifying Participation and Representation

Conversely, digital technology is a valuable tool to empower greater community participation in various fields. E-medical tools can help patients be more accessible to services, cultivating data sharing and coordination (Amann, 2017). Recent data collection, administration, and visualization developments permit different communities to engage in citizen science (Mazumdar et al., 2018). Partnership and contact online render community participation in administration and decision-making (Milakovich, 2010). International governance allows low-cost participation and social media tools to engage handicapped grassroots and decision-making approaches (Trevisan & Cogburn, 2019). Mazumdar et al. (2018) stressed that digital tools promise benefits but cautioned that demographics, price, and access must be considered when utilizing digital technologies. Overall, digital tools may democratize participation across the community. Targeted promotions and recruitment on social media platforms can penetrate different demographics. Social media can influence different participants, such as grieving parents (Johnson et al., 2019). Personalized social media engagements using algorithms and machine learning have been observed to increase participation and, at the same time, privacy issues (Mahato et al., 2024). A study revealed that political divergence in media channels, like well-written tweets, can influence political polarization and lessen left-right participation differences by 20.3% (Saveski et al., 2021). This revealed that well-crafted social media initiatives can penetrate different groups and individuals (Montgomery, 2018). For adult individuals, digital understanding is still a significant challenge, especially in medical services (Nimmons et al., 2022). Studies indicate that race and culture do not significantly influence self-care or demands for medical treatments, but visual insertion and different representations in digital technology remain critical (Nimmons et al., 2022).

Richer Data Collection and Analysis

Investigators can access and process multiple data sets with recent technologies. For example, GPS and digital cameras can monitor environmental exposures and ads for beverages containing sugar adjacent to school campuses (Holt, 2015). The pavement status assessment and crack identification can be done using video and laser arrays of data amalgamation (Haas & Hendrickson, 1991). IoT (Internet of Things) gathers sensor information from various gadgets in the entire network for real-time and historical interpretations (Gupta, 2015). Low-Power Wide Area Networks (LPWANs) can release a small amount of information in different circumstances with long-range and low-power usage (Oliveira et al., 2017). These tools can capture text, pictures, video records, location, and sensors, helping academe and practitioners around medical and facilities management obtain and process information. Artificial Intelligence and Machine Learning are tools for interpreting and processing multiple datasets, looking for trends, and gaining perspectives across businesses. These applications handle volumes of information in real time, automating procedures and advancing decision-making (Mohd Naved, 2022). For example, AI-based retail services can provide necessary business perspectives from consumer, product, and sales information (Vijayalakshmi & Thiyagarajan, 2023). Big data, therefore, brings numerous opportunities for machine learning algorithms that use statistics to produce results without programming. (Bakshi & Bakshi, 2018). AI can predict risks like injury, process advanced imaging, assist patients, and enhance telemedicine processes (Ramkumar et al., 2020). Though constraints like data integration and scalability were being raised, AI and ML research and innovations are advancing business operations (Mohd Naved, 2022; Vijayalakshmi & Thiyagarajan, 2023). Other fields that benefitted from citizen science were earth observation and climate science, crowdsourcing, real-time data gathering, and public participation (Fritz et al., 2017; Muller et al., 2015). Furthermore, these approaches can help with disaster mitigation and response, monitoring of the ecosystem, and pluvial flood mitigation (Fritz et al., 2017; See, 2019). However, information quality and authentication remain significant challenges (Fritz et al., 2017; Muller, 2015).

Fostering Collaboration and Knowledge Sharing

Digital technology aided medical and social researchers engage the respondents and stakeholders. Interactive online applications allow patient engagement and data sharing among medical providers, clients, and researchers (Robinson, 2009; Amann, 2017). It enhances global linkages and cooperation including information sharing resulting in medical care research and application more inclusive (Amann, 2017). Organizations in the community embrace digital exchanges to maintain social unity and relevance, including inclusion in times of the pandemic (Ratnam et al., 2020). Though these digital tools promise many benefits, they must be capitalized to link stakeholders and share data in a collaborative manner (Amann, 2017; Ratnam et al., 2020). Faraj et al (2011) opined that the digital world leveraged knowledge sharing and cooperation. The online platform enhances collaboration between individuals with varied interests. Certainly, this resource-sharing accelerates products faster through social capital (Sheng & Hartono, 2015). An adaptable online world develops information-sharing and opportunities, demanding innovative solutions to maintain productivity (Faraj et al., 2011).

Real-time Feedback and Iterative Processes

Involving respondents and stakeholders demands digital technology in medical care and social research. Professionals, consumers, and researchers may share knowledge and involve patients via web-based digital tools (Robinson, 2009; Amann, 2017). According to Amann (2017), these technologies can facilitate universal cooperation and data sharing, making medical care research and praxis comprehensive. For example, in autism, researchers suggest an inclusive method to develop technology that shall address the demands of autistic individuals and their loved ones (Parsons et al., 2019). Furthermore, these tools can be beneficial if used to link the stakeholders and share data collaboratively (Amann, 2017; Ratnam et al., 2020). Conversely, mission, jobs, and socio-demographics affect the society's content and duties (Hara & Sanfilippo, 2016). Determining the value of confidence and practicality matters to data sharing in the online world and remains vital (Sharratt & Usoro, 2003).

The Challenges of Participatory Research

Digital Divide and Accessibility Issues

The challenge of the digital divide is vital in this discussion, exacerbated by unequal access and use of digital technology (Dijk, 2017; Dijk, 2017; Gorski, 2005; Vavekanand & Dayanand, 2024). Disparities stem from different layers of motivations, skills, and usage (Dijk, 2017). These challenges directly affect the poor and the marginalized (Gorski, 2005), depriving them of access to social and economic opportunities. Dealing with this constraint demands layers of interventions and approaches specifically leveraging affordable Wi-Fi access (Aghdam et al., 2022; Crowcroft et al., 2014), imbued digital training (Abiddin et al., 2022; Whiteside et al., 2022; Prasastiningtyas et al., 2024; Adeleye et al., 2024), and tackling the needs of the countryside needy communities (Vavekanand & Dayanand, 2024; Abiddin et al., 2022). This calls for collaboration among authorities, NGOs, and private entities to facilitate equitable access, mend the skills gap, and capacitate individuals to be at par with the digital era.

Data Privacy and Security Concerns

One of the issues in the discussions about digital technology is privacy and security, data security breaches, and exploitation. This calls to raise the bar for awareness and protect individual data privacy and rights (Alfonsi & Berliri, 2021). Data breaches and spying entail legal impediments; therefore, robust data security is valuable (Garg et al., 2024). Furthermore, Algorithmic biases and discrimination,

particularly against the poor and marginalized, are problems connected to data-driven decisions, and machine learning algorithms are becoming widespread (Shubham et al., 2023). Research practitioners recommend ethical observance, transparency, and accountability in different datasets to brace these constraints (Shubham et al., 2023). Establishing a thorough data security system demands public and private collaborations (Garg et al., 2024). The monitoring of scientific studies has recently heightened, and ethical considerations have become paramount (Alfonsi & Berliri, 2021; Combe, 2015).

Bias and Algorithmic Discrimination

Bias in AI and ML systems is an emerging issue directly related to our community's social aspect (Fu et al., 2020). Data collection, feature selection, and algorithmic systems are perceived as causes of bias in AI advancement (Sharma & Rathodiya, 2019). These prejudices can extend to medical care, criminal justice, and other discrepancies (Nazer et al., 2023). Research practitioners encourage layers and comprehensiveness of research individuals, critical data filtering, and continual directing and supervision to lessen bias (Fernandes & Graglia, 2024). Sharma and Rathodiya (2019) suggest establishing equality, heightened algorithmic openness, and using unbiased methods. Other mitigating measures are to promote inter-collaboration and subscribe to ethical principles and paradigms to leverage AI System legitimacy and liability (Nazer et al., 2023; Fernandes & Graglia, 2024). To attain equal and collectively responsible goals, academe, government, and other stakeholders should relentlessly tackle algorithmic prejudices.

Maintaining Authenticity and Trust

The digital world is complicated. Prejudices, sentiments, time limits, and lack of enabling legislation matter to the trustworthiness of the online ecosystem (Kyza & Varda, 2019). We observe the proliferation of fake news, conspiracies, and deceitful social media distorting public perceptions (Ciampaglia et al., 2018). These challenges can be dealt with using different research techniques. Rodrigues Teixeira and Junqueira Barbosa (2020) suggest that a person can choose reliable sources and delineate digital objects by indulging in derivative data. Conversely, one should verify the digital sources' validity, truthfulness, and credibility (Jacobs, 2024).

Ensuring Data Quality and Validity

Internet-based data collection tools can make data quality and rigors challenging. Sampling bias, Population, and data quality are essential (Newman et al., 2020; Wardropper, 2020). Samples, transparency, and ethically motivating respondents are odds for investigators (Newman et al., 2020). Online committees are gaining momentum yet concerns about data quality and prejudice remain an issue (Callegaro et al., 2014). To enhance the data, (Wardropper et al., 2020) suggest that researchers should account for the sampling and non-response, construct survey instruments for different devices, and utilize rigorous data. Tufekci (2024) identified factors that complicate social media big data analytics, including tools-related biases, unrepresentative sampling paradigms, and sociocultural aspects. To address these factors, researchers should apply measures like leveraging various approaches to secure data quality and sample representativeness and determine the data according to its social context (Callegaro et al., 2014; Tufekci, 2014)

Ethical Realistic Viability

Participant Protection and Consent

The digital era offers and challenges informed consent and participant protection in research. Online techniques improve recruitment and data gathering but increase privacy, permission, and safety problems (Pisani et al., 2016). Researchers must balance technology benefits with participant safety. Remotely gaining meaningful informed permission, securing sensitive data, and defining safety expectations are major issues (Pisani et al., 2016; Charles & Magtanong, 2022). Online consent and anonymity are complicated by public/private places (Sugiura et al., 2017). To overcome these difficulties, design individualized, stepwise consent processes, increase investigator trust through participant contacts, and adopt strong confidentiality safeguards (Rosser et al., 2009). Online research requires rethinking ethical principles, including informed consent and participants' perspectives of public vs private information (Sugiura et al., 2017; Charles & Magtanong, 2022).

Prejudices in AI and ML

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Power Dynamics and Equity

A recent study emphasizes power dynamics and equality in research. Participatory research may empower marginalized groups, maximize involvement, and enable different voices (van der Riet & Boettiger, 2009). Web-based platforms can improve research equity, diversity, and logistics (Seth et al., 2023). Co-creating digital platforms with marginalized groups can promote inclusion and

engagement for low-literate persons (Loignon et al., 2021). Social media and online communications are changing researcher-participant power relations, which may improve equity but can raise ethical and methodological issues (Reich, 2015). These studies underscore the necessity for academics to actively address power inequalities, use inclusive tactics, and use technology to achieve equity and inclusion, especially when dealing with disadvantaged or underrepresented populations.

Best Practices and Future Directions

Design Principles for Inclusive and Ethical Research

Equitable and responsible technology-enabled public engagement requires user-centered design. User requirements may be identified using interviews, questionnaires, and usability testing (Luo, 2024). Dialogic ethics and participatory design may develop humane and effective technology (Salvo, 2001). Accessibility and inclusiveness are needed to engage all users, especially those with disabilities (Luo, 2024; Okimoto et al., 2018). Design should consider growth and ecology (Parlangeli & Liston, 2023). Examples include writing online programs and tactile signals for blind people (Salvo, 2001). These notions require additional sensibility and knowledge from the design team, especially when working with impaired persons (Okimoto et al., 2018). Combining these strategies can help designers create more engaging, inclusive, and effective technology experiences for diverse user needs.

Building Trust and Transparency

Community-engaged research builds trust and transparency via iterative, straightforward interaction and mutual respect (Han et al., 2021). Involve local stakeholders throughout the study, establish duties, and address difficulties swiftly (Skewes et al., 2020; Salmi, 2023). Researchers should establish community liaisons, personalize communication, and engage with groups following presentations (McDavitt et al., 2016). Disclose how data is used, security, and research consequences (Salmi et al., 2023). CBPR can help marginalized groups overcome mistrust (Skewes et al., 2020). Distribution is promoted by interactive presentations, community involvement, and debate (McDavitt et al., 2016). While measuring community results is difficult, these measurements can boost trust, participation, and health disparities research relevance and sustainability (Han et al., 2021; Skewes, 2020).

Developing a Skilled Workforce

Learning digital research methods is becoming increasingly crucial as social research moves digital (Pink, 2019). Digital techniques present challenges and opportunities for social researchers, technology professionals, and community members to collaborate (Roberts et al., 2013). Collaboration can bridge technological gaps and develop ethical standards (Parti & Szigeti, 2021). Qualitative data linkage and survey abilities are needed for future public engagement (Wiles et al., 2009). Researchers must additionally consider online and online ethics, non-academic user participation, and policy and procedure effect assessment (Wiles et al., 2009). Academic institutions must support open science and transdisciplinary collaboration to enhance social science research (Parti & Szigeti, 2021).

Emerging Trends and Future Direction

Technology changes the design of cities and environmental management in citizen science. VR, AR, AI, and GIS offer complete immersion in visualization and decision-making, increasing public involvement (Berigüete et al., 2024). These methods enable massive biodiversity and environment monitoring, promoting involvement regardless of expertise (Sheard et al., 2024). Open science, networked science, and internet-based activities can engage non-traditional citizen scientists (Newman et al., 2012). Higher pricing, technical knowledge, and diminished human connection may be problematic (Sheard et al., 2024). Overcoming these challenges and profiting from technology requires proactive and open governance. Online communities, citizen juries, and collaboration can help create technologies that benefit the community, economic growth, and the natural world (Adedeji, 2021).

Conclusions

This narrative review highlights the transformative potential of technology in shaping the future of public engagement and participatory research. Critical analysis centers on the opportunities of internet-based technologies that enhance accessibility and inclusivity, diversify participation and representation, richer data collection and analysis, foster collaboration and knowledge sharing, and real-time feedback and iterative processes. Despite these promises of digital tools, challenges remain: the digital divide, data security, and privacy, prejudices of AI and ML, authenticity and trust issues, rigors of data, and ethical considerations. Conversely, digital technology can accelerate community participation in participatory research, but it is valuable that a researcher must be armed with an analytical and reflective lens. To address these constraints, researchers should acknowledge the perils of technology-based tools by underlining ethical concerns and cultivating creativity and responsible innovation for a comprehensive and democratic community. Ongoing studies, experimentation, and conversations about this field are valuable to understanding the beauty of technology, helping the community's welfare, and capacitating individuals to engage in meaningful dialogue that will shape our future and future generations. Moreover, this study stressed the significant outcomes highlighting the significance of ethical considerations, responsible stewards of innovations and technology, and continued conversations on the dynamics of technology-based community participation. Maming, Escarilla, Taño-an, and Flores's Participatory Feminist Democracy Framework is proposed.

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