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Kevin Muriithi Ndereba*[1], Ukaiko Bitrus-Ojiambo[2], Paul Ruto[3], and Grace Kinyanjui[4]

* Corresponding Author
[1] St. Paul's University, Kenya and Research Fellow, Stellenbosch University, South Africa.
[2] St. Paul's University, Kenya
[3] St. Paul's University, Kenya
[4] St. Paul's University, Kenya

Citizen Science Engagement Initiatives in Kenya and Tanzania: Fostering Digital Transformation and Inclusive Knowledge Ecosystems

Keywords:
Citizen Science, Digital Transformation, Open Science, Kenya, Tanzania, Knowledge Management, FOSTER Project—an EU-funded initiative, Science Shops.

Abstract

This research presents the initial findings and strategic frameworks of the FOSTER Project (Fostering Digital Transformation of Science in Kenya and Tanzania), an EU-funded initiative (Erasmus+ CBHE) aimed at modernizing the research ecosystem in East Africa. The paper focuses on the promotion of Citizen Science (CS) in Sub-Saharan Africa through the Science Shop 2.0 model across Higher Education Institutions in Kenya and Tanzania. This research used a multi-phase case study and purposive sampling approach, primarily among five Higher Education Institutions (HEIs) in Kenya and Tanzania. The first phase entailed mixed-methods surveys on CS skills gaps, practices, and mainstreaming in national policies in select HEIs among 235 participants in the two countries. The second phase included a baseline comparative analysis of CS implementation across the five partner institutions, focusing on the current situation, key barriers, and emerging opportunities for CS, among 190 participants. The third phase entailed stakeholder workshops conducted during mobility visits to partner institutions in Kenya and Tanzania, focusing on the transition to open science practices. Across the combined valid sample, more than half of the academic and research staff and students were aware of CS, although CS practices remained minimal. Second, the Science Shops approach has several benefits in strengthening the social relevance of academic research and promoting knowledge democratization by allowing communities to contribute to scientific inquiry. Third, several structural and institutional barriers continue to limit widespread adoption. One significant challenge relates to intellectual property and data ownership concerns. Fourth, institutional leadership and policy support play a central role in embedding CS within HEIs. Fifth, international collaboration and mentorship provide valuable opportunities for knowledge transfer and capacity building in CS implementation. Sixth, technological infrastructure plays a foundational role in enabling CS ecosystems in Sub-Saharan HEIs.

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The paper provides a scalable roadmap for strengthening the role of Citizen Science (CS) and Open Science (OS) in fostering digital transformation and inclusive knowledge ecosystems in East African HEIs. The paper also contributes to ongoing discussions on participatory research and knowledge democratization in the Global South. This is achieved through digital inclusion, community-engaged research, and sustainable development.

1. Introduction

In a complex, rapidly changing global landscape, the traditional boundaries between academic research and societal needs are increasingly blurred. Citizen Science (CS) and Open Science (OS) are research practices anchored in the ethos of participation, collaboration, transparency, and accessibility of science and information in society. Within the knowledge ecosystem, these practices ultimately create a bridge between academia and communities. Hulbert et al. (2019) posit that CS engages non-scientists in research processes, expanding research participation beyond data gathering to community education and empowerment (Vicente-Saez & Martinez-Fuentes, 2018). Within the larger framework, OS makes research findings available to wider research communities, thereby providing a launching pad for future research trajectories (Mukherjee & Stern, 2009). This research adopts the UNESCO (2021) definition of OS, which seeks to ensure that the production of scientific knowledge itself is inclusive, equitable, and sustainable.

While OS has gained global momentum, its adoption in Sub-Saharan Africa remains uneven due to infrastructure gaps, limited community engagement, diminished project funding support, inadequate data collection skills, questions around data quality, inadequate project management, and lack of sustainability (Foster & Deardorff, 2017; Hulbert et al., 2019). Mitigating these challenges would strengthen the contribution of OS practices to the United Nations Sustainable Development Goals (SDGs). Although both SDGs and OS have independently framed guidelines, their interpretation and integration are not always clear (Chew et al., 2024). OS frameworks allow teams to use various scientific workflow activities, including the creation of free research accounts that provide dashboards and wikis for project development, online platforms for sharing data and monitoring progress, and even external integration with other sites (Foster & Deardorff, 2017). These frameworks provide technical enhancement for project implementation. However, given the digital divide and marginalization of African research in the global research environment, these frameworks could also limit the implementation and sustainability of CS and OS.

The FOSTER Project, "Fostering Digital Transformation in Kenya and Tanzania" (Ref. No. 101178078), is co-funded by the European Commission through Capacity Building in Higher Education (CBHE). The aim of the project is to strengthen inclusive, collaborative, and responsible science, technology, and innovation ecosystems through the implementation of Open Science (OS) in Kenya and Tanzania Partner Countries (PCs). St. Paul's University (SPU), Kenya, is one of the nine participating universities drawn from Kenya, Tanzania, and Europe. Other FOSTER Project partners include Daystar University, Kenya (Project Coordinator); Garissa University, Kenya; the University of Dar es Salaam and the Eastern and Southern African Management Institute (ESAMI) in Tanzania; the University of Zaragoza (Spain); the International School for Social and Business Studies (ISSBS) in Slovenia; Vrije Universiteit Amsterdam (VU), Netherlands; and the European Policy Development and Research Institute (EPDRI), Slovenia, the Project Co-Coordinator. This paper explores the project's multidimensional approach to managing capacity building, policy reform, and technological innovation for CS practices, and analyzes the pilot phase of the project's citizen engagement initiatives in fostering "Learning Beyond Boundaries."

2. Literature Review

Citizen Science (CS) is a participatory approach that includes the contribution of citizens within the scientific enterprise (Elias et al., 2023; Hecker et al., 2018). Elias et al. (2023) observe how the rise of professional scientists is a recent phenomenon of the 19th century and how scientists such as Charles Darwin (naturalist, geologist, and biologist) and Carl Linnaeus (a Swedish botanist and physician) included the input of citizen volunteers in their scientific experiments. It has since developed into a global movement through the formation of associations and societies such as the European Citizen Science Association (ECSA), the Citizen Science Association (CSA) based in the United States, and the Australian Citizen Science Association (ACSA), as well as national networks in countries including Germany, New Zealand, China, and Austria. Vohland et al. (2018) observe that these networks "are transitioning from loose networks to legal entities." Several CS initiatives, networks, and associations also exist in the African region, including the CitSci Africa Association, CISCA (Citizen Science for Conservation in Africa), and MAKENYA (Mammal Atlas Kenya), as shown in Table 1 below.

Table 1: Existing CS initiatives, networks and associations in the African region

	CS Network / Association	Host	Purpose
	Africa Region		
1	CitSci Africa Association	United States International University-Africa (USIU-A) in Nairobi	This continental network supports citizen-generated data to monitor sustainable development and conservation policies across Africa
2	CISCA (Citizen Science for Conservation in Africa)	Tropical Biology Association	An active network launched by the Tropical Biology Association that translates biodiversity monitoring into effective decision-making in Liberia, Benin, Nigeria, Cameroon, Uganda, Kenya, Tanzania, DRC and Botswana.
	Kenya		
3	MAKENYA (Mammal Atlas Kenya)	National Museums of Kenya	Run by the National Museums of Kenya via the SPOTTERON platform, this app enables everyday naturalists to map the distribution of Kenyan mammals.
4	Nairobi River Citizen Science	FreshWater Watch	Equips community groups to test and restore water quality in the Nairobi River basin.
5	PROCOL Kenya	Nairobi, Kenya	Engages local residents in research sites to develop methods for monitoring local health, environmental, and socio-economic challenges.

These projects implement the "ten principles of citizen science" elaborated by Robinson et al. (2018). These principles illustrate how citizens can be included in any stage of the scientific process—research questions, design, data collection, analysis, and dissemination—as contributors, collaborators, and project leaders, and how both scientists and citizens benefit from scientific endeavour when results are made publicly available for dissemination and accountability.

The rise of digital technologies in the form of networked media and media devices has provided new opportunities for citizens to participate in astronomy, biology and biodiversity monitoring, environmental

monitoring, and public health (Hecker et al., 2018). The involvement of citizens in scientific initiatives is also based on increased levels of education and the centrality of science in shaping policy and culture. Beyond these threads within African Citizen Science (CS) initiatives lies a close link with postcolonial discourses. In the African context, CS can be attributed to the ways in which African populations were often sites of "scientific colonialism" in the context of vaccinations and similar interventions. Thus, CS initiatives are premised on political activism, social action, and advocacy, particularly within the growing climate and environmental crises (Elias et al., 2023). Austen et al. (2024) observe that CS has the potential to challenge "the more dominant ways of doing, thinking, and organising in science—which we refer to as the institutionalised science system."

Another way that CS is approached within the postcolonial African context is through the place and role of "Indigenous Knowledge Systems" (IKS). The discourses around IKS question the modern framework undergirding scientific enterprises and seek to recover the role of African knowledge(s) that were central in the life of various communities. These knowledge(s) enhanced historical identity, health systems, and cultural and religious knowledge(s), which embraced a holistic view of engaging with the world. Leach and Fairhead (2002), for example, note how communities in Trinidad and Ghana used Indigenous knowledge for the purposes of resource-use monitoring. Thus, documenting such Indigenous practices expands citizen participatory approaches and creates clear linkages between IKS and CS paradigms (Hecker et al., 2018; Sam et al., 2022; Tengö et al., 2021). The involvement of the community within the scientific process is seen as contributing more contextualized and relevant interventions from research, expanding a sense of ownership and contributing to sustainable policy and development. Research efforts within various African contexts now take seriously issues of inclusion of marginalized voices in the research process.

Lee et al. (2022) and Weingart (2021) provide a case of CS in the South African context. Elias et al. (2023) have mapped several CS initiatives in Africa. Their research shows that several regionally representative projects on the continent tackle WASH, resilience of vulnerable populations, and open data. Our paper focuses on the role of CS within the African higher education, research, and innovation landscape, as this remains an underexplored area (UK Department for International Development, 2020). We approach CS through the FOSTER project, which is aimed at the digital transformation of science in Kenyan and Tanzanian Higher Education Institutions. While some scholars, such as Mabotha and Ngcamu (2025) and Zeleza and Okanda (2021), have explored the role of digital transformation in higher education, and Ajani (2024) explored the role of open science in the African context, little connection has been made with the CS paradigm in the East African higher education context. Pocock et al. (2018) focus on CS in biodiversity and environmental conservation, Kelly et al. (2022) on land management, and Kahl (2023) on citizen data in law courts in East Africa; however, much more research needs to be conducted within the higher education context.

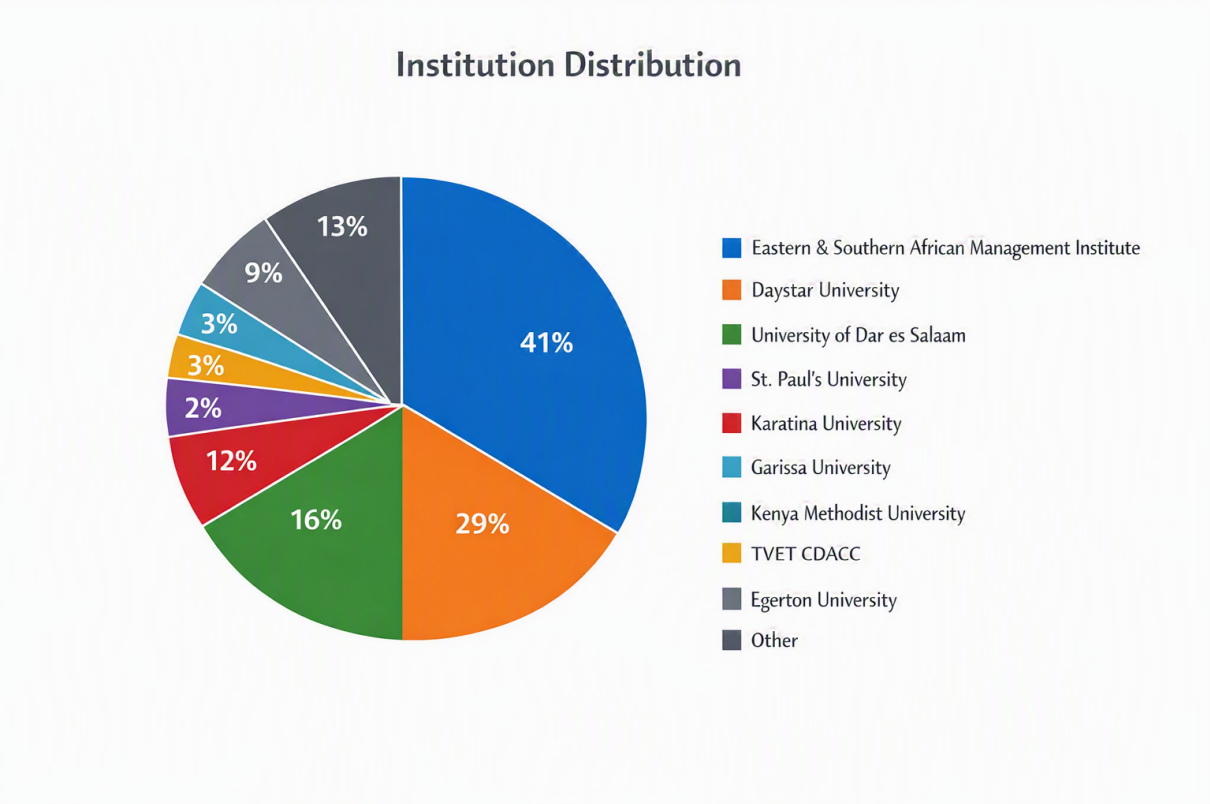
The FOSTER project is aimed at creating "Science Shop 2.0 models" or "OS hubs" that will help transition from traditional "expert-led research" to a community-driven research and innovation ecosystem. Research and innovation in Kenya is supported through various policies, including the Science, Technology and Innovation Act 2015, which mandates various organizations to strengthen the research and innovation landscape, including the National Research Foundation (NRF), the National Commission for Science, Technology and Innovation (NACOSTI), and the Kenya Innovation Agency (KENIA); the country's national Vision 2030; the African Union's Agenda 2063; and efforts by the Network of Scientific Academies (NASAC, 2025), among others. While Hulbert et al. (2019) provide a case study of a CS education project called "the Limbovane Outreach Project" in Stellenbosch, South Africa, this paper expands the CS research context by considering five HEIs in Kenya and Tanzania. This paper also examines the role of strengthening the CS framework that can materialize the intentions of the various policies and acts, while contributing to the role of higher education.

3. Data and Methodology

Research Design

The mixed-methods approach enables analytical depth and comparison of Citizen Science implementation across the participating institutions in Kenya—Daystar University, St. Paul's University, and Garissa University—and in Tanzania—the University of Dar es Salaam and the Eastern and Southern African Management Institute—as well as other invited institutions in both countries, including Karatina University, Kenya Methodist University, TVET CDACC, and Egerton University, among 235 participants (n = 235), as shown in Figure 1 below.

Figure 1: Institutional Distribution of Participating Universities



Data Collection

The first phase entailed detailed needs assessment surveys in HEIs in the region as follows: open science skills gaps in Kenya and Tanzania, Citizen Science practices, and mainstreaming of OS at national and university levels. Quantitative and qualitative data were collected by partner institutions in Kenya and Tanzania through surveys from 235 respondents from partnering and invited institutions. Respondents included institutional leadership, policymakers, academic and research staff, technical and research support staff, and postgraduate students. The second survey covered insights, current practices, and experiences of Citizen Science (CS), community-based participatory research (CBPR), and public engagement activities in the Kenya and Tanzania higher education sectors, with respondents drawn from students, staff members, and institutional partners (n = 190). The additional research instrument was a baseline comparative analysis of Open Science implementation across the five partner institutions, with a key focus on the current situation, key barriers, and emerging opportunities for OS.

The second phase of data collection entailed stakeholder workshops conducted during mobility visits to partner institutions in Kenya and Tanzania on the transition to open science practices; to VU in the

Netherlands on Science Shop 2.0 (June 2025); to the International School for Social and Business Studies in Slovenia on OS curriculum (September 2025); and to UNIZAR in Spain on OS policy (October 2025). Qualitative data collected from these interactions included progress reports on citizen engagement initiatives in Kenya and Tanzania.

The final phase of the data focused on the pilot "Open Science Hubs." Each institution is expected to roll out a hub to integrate the Science Shop, capacity building, policy, and technological innovation. The experience of the open science hub formed an integral source of qualitative data on digital transformation and inclusive knowledge ecosystems.

Research Ethics and Transparency

Ethical clearance was provided through the project coordinator, Daystar University's Ethics Board, and covered key areas such as confidentiality, consent, beneficence, and human dignity for all research participants. All datasets, reports, and related materials are also available upon request through institutional repositories, in line with EU project guidelines.

Data Analysis

The analysis proceeded in three stages. First, quantitative survey results were organized descriptively to establish the distribution of awareness, participation, and perceived skills gaps across the participating institutions and countries. Second, qualitative documents, workshop reports, and institutional project records were coded thematically around five analytical categories: awareness-practice gap, institutional readiness, community participation across the research lifecycle, policy and governance support, and technological infrastructure. Third, findings from the survey data were triangulated with documentary and workshop evidence to identify convergences and divergences between Kenya and Tanzania and among the participating HEIs. This approach enabled the study to move beyond description by examining how institutional, policy, and infrastructural conditions shape the implementation of Citizen Science and Open Science practices.

4. Results

Overview

Taken together, the findings indicate that the main challenge is not the absence of awareness or interest in Citizen Science, but the weak institutionalization of participatory practices across the full research lifecycle. Survey data show relatively high levels of awareness, while project-level evidence reveals limited community participation in co-design, tool development, data analysis, authorship, and post-project engagement. This contrast suggests an awareness-practice gap: HEIs increasingly recognize the value of Citizen Science, but institutional procedures, incentive systems, digital capacity, and governance frameworks have not yet evolved sufficiently to support sustained implementation. The conclusions of the paper are therefore grounded in the observed relationship between awareness, institutional readiness, and actual participatory practice.

The study has five key findings. The first is based on regional comparisons. The study found variations in engagement strategies between Kenyan and Tanzanian partner institutions (e.g., policy environments and digital infrastructure), and although awareness of OS is present, practice is still minimal. Second, although CS approaches are used in HEIs, the role of Science Shops in bridging the gap between academia and local industry/NGO initiatives has not yet been realized. Third are barriers to OS and CS adoption, linked to concerns about intellectual property in research, lack of digital literacy, and the maintenance of traditional

academic silos. Fourth is the juxtaposition of enablers of success, including leadership support, international mentorship, and the fostering of collaborative cultures. Fifth is the role of interoperable repositories and FAIR data principles in making local science visible.

Regional Comparison

Although Kenya and Tanzania share many socio-economic and historical characteristics, their science, technology, and innovation (STI) ecosystems have evolved along different institutional and policy trajectories, influencing the adoption and implementation of citizen science initiatives across three key areas: digital infrastructure, citizen science framework, and policy infrastructure. Kenya has traditionally maintained a relatively robust research and digital infrastructure ecosystem, supported by national organizations such as the Kenya Education Network (KENET) and the Kenya National Research Fund (NRF). Lugasi and Odhiambo (2022) observe that these institutions provide high-capacity research connectivity and funding mechanisms that facilitate collaborative research and digital knowledge sharing. As a result, Kenyan universities have been able to leverage stronger ICT infrastructure and private-sector innovation ecosystems, particularly in areas such as internet bandwidth, mobile technology, and digital data platforms, to support citizen science initiatives (Muriithi et al., 2016). By contrast, Tanzania's STI landscape has historically been shaped by a state-led development approach, with stronger emphasis on industrialization, technology transfer, and SME development (Diyamett et al., 2016).

Table 2: Awareness Levels of CS in Kenyan and Tanzanian Institutions

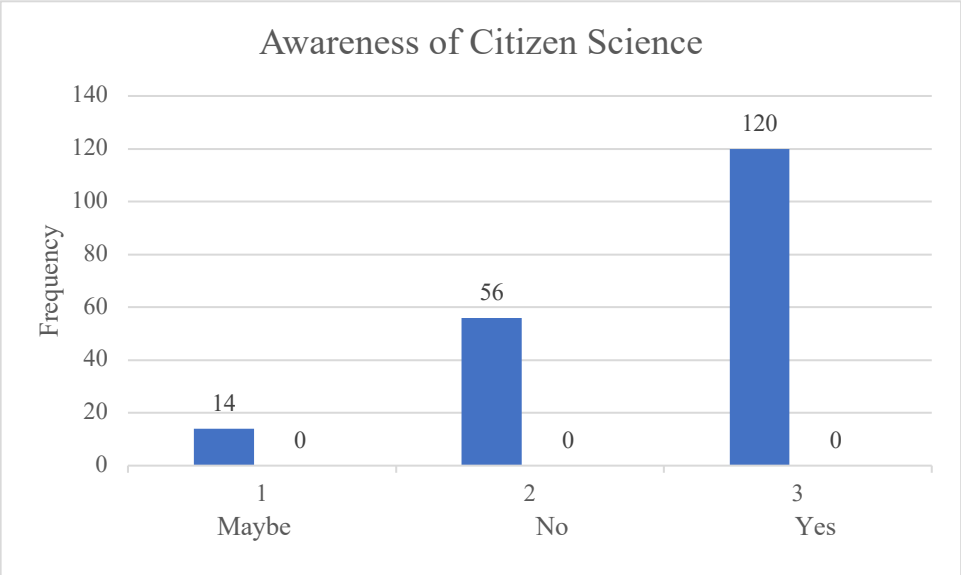


Table 2 above shows high awareness levels of CS among the partnering institutions in Kenya and Tanzania (n = 190), with 63% of respondents indicating awareness (n = 120 "yes"), while the practice skills gap stands at 58%. Tanzanian universities and research institutions have increasingly begun integrating open science and citizen science frameworks, but adoption has been gradual due to structural constraints such as limited digital infrastructure, uneven connectivity across rural areas, and evolving policy frameworks (Klein et al., 2025). A similar practice is discernible in Kenyan universities, where the partner institutions are minimally integrating citizen science frameworks in their research.

These differences highlight how national policy environments influence the trajectory of citizen science adoption. Kenya's relatively mature digital ecosystem enables more rapid integration of participatory

research models, while Tanzania's emerging innovation system emphasizes the alignment of citizen science with national development priorities and industrial transformation agendas. Additionally, institutional policies and strategic plans around open science, citizen science, and research and innovation ecosystems strengthen CS awareness. At SPU, for example, funding from local and international donors has strengthened various CS projects in healthcare, nursing, agriculture, and mental health resilience.

Furthermore, the SPU-specific document analysis of five projects involving Kenyan communities—in the areas of gender and development, agriculture and national advocacy, health research and policy brief development, leadership training, and mental health—observed CS integration in research development and strategy. Two key pillars were noted. First, OS integration in the wider institutional strategic plan emphasized innovation, digitization, and socially responsive research, corroborated by the 63% awareness found in the valid survey sample. Second, community engagement during project co-creation and problem identification was achieved in all five projects (Vicente-Saez & Martinez-Fuentes, 2018). However, during objectives development and tool design for fieldwork, all five SPU projects did not take a collaborative approach (Foster & Deardorff, 2017; Hulbert et al., 2019).

At the data collection stage, it was found that only two programs (40%) took a collaborative approach. Interestingly, all were engaged together in data validation (100%). However, data analysis was conducted independently. As for the results and feedback to the community, all five projects gave feedback to the communities (100%). Regarding authorship and attribution, all five projects did not incorporate non-institutional members in the authorship of the projects. Lastly, regarding research outcomes, community-led action in the projects was undertaken by two of the programs (40%), mutual learning was found in all programs (100%), while none had future engagements beyond the project lifecycle. From the feedback by participants in both countries, more than half of the academic and research staff and students in the combined valid sample are aware of Open Science. However, as seen in the SPU-specific document analysis of five projects, practice remains minimal. The FOSTER project provides a strategic roadmap for open science mainstreaming for ethical, interoperable, and participatory research infrastructure. The creation of awareness and integration of citizen science in research is gaining momentum, and there is a need for policy, skills, and infrastructure support.

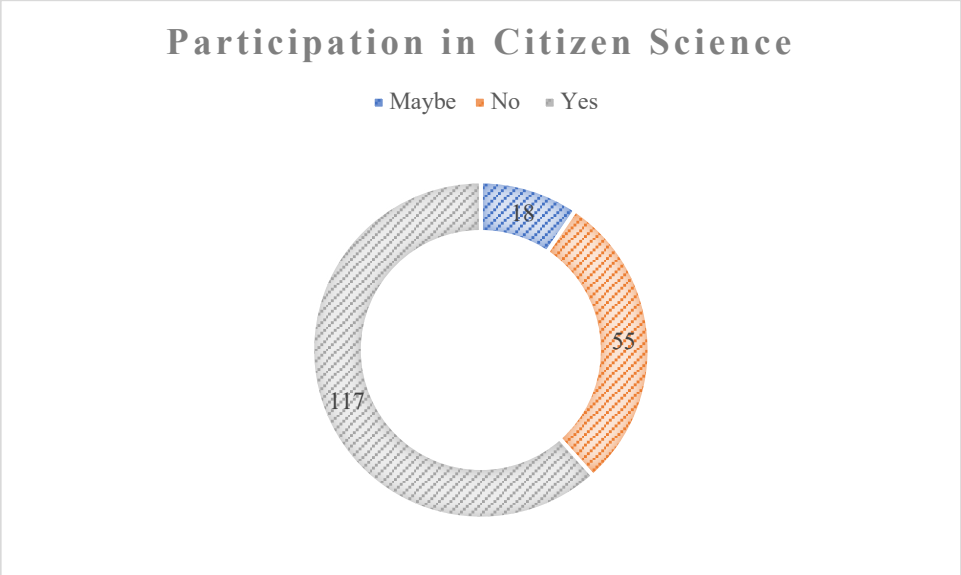
The comparison between Kenya and Tanzania suggests two distinct but complementary pathways for Citizen Science adoption. In Kenya, stronger digital infrastructure, research funding mechanisms, and university-level innovation strategies appear to support earlier experimentation with community-engaged research, as illustrated by SPU's portfolio of projects in health, agriculture, advocacy, and mental health resilience. However, the Kenyan cases also reveal that stronger infrastructure does not automatically translate into deeper citizen participation, since community involvement remains concentrated in problem identification, data collection, validation, and dissemination rather than in co-design, analysis, and authorship. In Tanzania, the adoption pathway appears more closely linked to national development priorities, industrial transformation, and emerging policy frameworks. The implication is that Kenya may offer stronger enabling infrastructure, while Tanzania offers a clearer opportunity to embed Citizen Science within national development agendas. Across both countries, the evidence points to the need for institutional mechanisms that convert awareness into sustained participatory research practice.

Public-Private-Community Partnerships

The research data reveal high levels of participant engagement with citizen science approaches, even though much of this participation is limited to crowdsourced data collection. Figure 2 below shows that a majority of the valid survey respondents were engaged in citizen science initiatives—that is, those who answered "yes" (62%, n = 117). A minority of respondents answered "no" (29%, n = 55), and very few answered "maybe" (9.5%, n = 18). Inferentially, the "maybe" cohort shows that the term "citizen science" may still

be an emerging concept within the East African higher education context, and participants may be familiar with other terminology, such as community engagement.

Figure 2: Research Participant Engagement with Citizen Science Initiatives



One of the most promising mechanisms for institutionalizing citizen science in East Africa is the development of multi-stakeholder partnerships involving universities, civil society organizations, private-sector actors and citizens (Kitaka et al., 2024). Within this framework, the concept of "Science Shops" has gained increasing relevance. Hidalgo (2021) notes that Science Shops are intermediary structures that connect academic researchers with community organizations, NGOs, and industry partners to address real-world problems through collaborative research. Originating in Europe, the Science Shop model has been adapted in African contexts to facilitate demand-driven research and enhance community participation in knowledge production.

In the context of the FOSTER project and SPU's collaborative initiatives, Science Shop-like models provide a platform through which universities can partner with NGOs and development organizations working in initiatives such as Water, Sanitation, and Hygiene (WASH), environmental sustainability, and public health. Through these partnerships, community groups can propose research questions, participate in data collection, and co-develop solutions with academic researchers.

According to Brodersen (2010), Science Shop approaches have several benefits. First, they strengthen the social relevance of academic research. Second, they promote knowledge democratization by allowing communities to contribute to scientific inquiry. Third, they enhance research uptake and policy relevance by ensuring that research outputs respond to real societal needs. By facilitating mutual exchange between academia and society, Science Shops contribute to building inclusive knowledge ecosystems where universities function not only as knowledge producers but also as partners in community development. Further, the formal setup of the open science hub will help build and scale the inclusion of open science in universities and research institutions.

Barriers to Adoption

Despite the growing momentum behind citizen science initiatives in East Africa, several structural and institutional barriers continue to limit widespread adoption (Burgess et al., 2017; Mwelwa et al., 2020; Pocock et al., 2019). One significant challenge relates to intellectual property and data ownership concerns. Traditional academic research systems often emphasize proprietary ownership of research outputs, which can discourage researchers from sharing data openly or collaborating with external stakeholders. These concerns are particularly pronounced in contexts where institutional policies governing open data and intellectual property rights remain underdeveloped (Mwelwa et al., 2020).

Another major barrier is low levels of digital literacy among community participants, especially in rural areas where internet access and digital infrastructure remain uneven (Klein et al., 2025). While mobile phone penetration in East Africa is relatively high, the ability to participate effectively in digital data collection platforms, open repositories, or citizen science applications often requires additional training and technical support.

Institutional culture also plays a role. Many universities in the region continue to operate within disciplinary silos, with limited incentives for interdisciplinary collaboration or community-engaged research. Integrating trans- and interdisciplinary approaches within East African HEIs is seen as a solution to this "silo mentality" (Okafor et al., 2025). Another proposed solution is the incorporation and integration of a diversity of epistemological viewpoints as a pathway to Africanizing research and education in African HEIs (Hungwe & Mkhize, 2025). Mainstreaming Citizen Science in HEIs would entrench both solutions within the higher education landscape. Without appropriate reward systems, such as recognition of citizen science contributions in promotion and tenure frameworks, researchers may be reluctant to invest time in participatory research models.

Finally, policy fragmentation across national research systems can create inconsistencies in open science implementation. While both Kenya and Tanzania are gradually developing policies supporting open access and digital research infrastructures, differences in regulatory frameworks and funding mechanisms can complicate cross-border collaboration.

Enablers of Success

Several enabling factors have emerged as critical drivers for the successful adoption of citizen science initiatives in East African universities. First, institutional leadership and policy support play a central role. Leadership from university administrations such as those participating in the FOSTER consortium helps to mainstream open science principles within institutional strategies and research governance structures. Awareness events such as the Open Science Forum held in Nairobi in 2025 demonstrate how leadership engagement can mobilize stakeholders and build consensus around open science adoption.

Second, international collaboration and mentorship provide valuable opportunities for knowledge transfer and capacity building (Mwelwa et al., 2020; Okafor et al., 2025). Through staff mobility programs, study visits, and benchmarking exercises with European partner universities, participating institutions gain exposure to best practices in open science infrastructure, citizen science methodologies, and research data management.

Third, capacity-building initiatives including workshops, training programs, and curriculum development help develop the skills necessary to support participatory research approaches. These programs target both academic researchers and community stakeholders, ensuring that citizen science initiatives are inclusive and sustainable. Together, these factors contribute to the gradual emergence of a collaborative research culture that values openness, transparency, and community participation in knowledge production.

Technological Infrastructures

Technological infrastructure plays a foundational role in enabling citizen science and open science ecosystems (Mwelwa et al., 2020; Zeleza & Okanda, 2021). Within the FOSTER project framework, participating universities are working toward the development of interoperable research infrastructures that adhere to the FAIR data principles: Findable, Accessible, Interoperable, and Reusable.

Key components of this infrastructure include institutional repositories for research outputs and datasets, digital platforms for citizen science data collection and collaboration, and OS hubs designed to support interdisciplinary collaboration and knowledge sharing across institutions.

5. Discussion

A key practice for the success of Citizen Science (CS) projects from the literature points to early engagement among partners (community, academic, and/or industry). CS initiatives are pathways for social impact, empowering local communities to solve their own problems (e.g., climate adaptation, health hygiene, and environmental stewardship). For instance, through training in research and data collection methods, use of tools, and supervision, local research team members can be useful in monitoring and collecting data (Mwelwa et al., 2020). The impacts from such activities directly correlate with social justice policy developments and improved overall health impacts for communities. Social impact projects, though key in driving community change, must be embedded in sustainability, empowerment, and longevity of data access beyond the life of the project or organization.

A second consideration is the role of institutional impact. For instance, partnering institutions are "Learning Beyond Boundaries" by decolonizing the research process. Industry firms and academic teams, in the past, had to manage the boundaries of secrecy and use of technology, for example, to protect R&D processes, intellectual property rights, or patents (Jong & Slavova, 2014). Existing literature augments the levelling of barriers through the use of collaborative technologies and early participation in product development processes. Futuristic proposals can expand on the scalability of this model, that is, the multiplication and domestication of this framework. This speaks to the feasibility of replicating the FOSTER model in other Sub-Saharan African HEIs.

Third, this research shows that in East African HEIs, CS awareness is high, while participation can be strengthened. The analysis of five sampled community-based projects at SPU, for instance, as shown in *Table 2*, reveals that action research is utilized as a pillar of citizen science. These citizen engagement initiatives include problem identification, data collection, validation, and dissemination. The dissemination of community-based research initiatives by SPU is done using media platforms (radio and TV). The pillars that require improvement include, but are not limited to, project co-design, tool development, data curation, data analysis, and attribution of authorship or policy drafts.

The empirical findings support three broader conclusions. First, awareness alone is insufficient for institutional transformation; without policies, incentives, and technical support, Citizen Science remains episodic rather than embedded. Second, institutional readiness varies not only between countries but also across stages of the research lifecycle. The strongest forms of participation occur at problem identification, data collection, validation, and dissemination, while the weakest occur at co-design, data analysis, authorship, and long-term engagement. Third, comparative evidence from Kenya and Tanzania shows that digital transformation must be understood as both a technological and governance process. Investments in platforms, repositories, and Open Science hubs will be effective only when accompanied by reforms in research governance, community ownership, data rights, and academic reward structures.

6. Conclusion and Recommendations

Conclusion

Using the FOSTER project as a case study on citizen science initiatives, this paper argues that CS is not merely an academic trend but a transformative pathway for digital inclusion and "Learning Beyond Boundaries" in East Africa. The empirical evidence shows that HEIs in Kenya and Tanzania are beginning to integrate Citizen Science and Open Science into institutional strategies, research partnerships, and digital transformation agendas. However, the findings also reveal a significant gap between awareness and sustained practice. Participation remains strongest in problem identification, data collection, validation, and dissemination, but weaker in project co-design, data analysis, authorship, and long-term post-project engagement.

Policy Recommendations

To ensure the sustainability of these initiatives, national commissions—specifically NACOSTI in Kenya and COSTECH in Tanzania—should consider the following:

- Policy harmonization: Develop unified national frameworks for Open Data and Intellectual Property (IP) that protect community knowledge while encouraging open sharing.
- Academic incentive reform: Universities should reform promotion and tenure guidelines to formally recognize and reward community-engaged research and Citizen Science contributions.
- Infrastructure investment: Support the development of interoperable institutional repositories and regional Open Science Hubs that adhere to FAIR data principles (Findable, Accessible, Interoperable, and Reusable).
- Digital literacy funding: Allocate resources for training programs targeting both researchers and community members, particularly in rural areas, to bridge the digital divide.

Future Research Recommendations

As the FOSTER Project moves toward its 2027 conclusion, future research should focus on the long-term impact of the Science Shop 2.0 model on local economic development. Key areas for exploration include:

- Scalability: Assessing the feasibility of replicating the FOSTER model in other Sub-Saharan African HEIs to foster a wider regional knowledge ecosystem.
- IKS Integration: Deepening the connection between Indigenous Knowledge Systems (IKS) and modern scientific paradigms to ensure research is culturally relevant and decolonized.
- Virtual Impact: Evaluating the role of ODeL (Open, Distance, and e-Learning) platforms in maintaining longitudinal community engagement beyond the initial project lifecycle.

The establishment of the Sub-Saharan Open Science Hub will serve as a critical milestone in making local African science visible on the global stage, thereby closing the gap in research and societal impact (Coombs et al., 2025; Dotti & Walczyk, 2022).

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