ARTIFICIAL INTELLIGENCE 4 Climate Resilience

LEVERAGING ARTIFICIAL INTELLIGENCE FOR CLIMATE RESILIENCE SOLUTIONS IN AFRICA

CAPACITY NEEDS ASSESSMENT REPORT

Prepared by:
Africa Research and Impact Network (ARIN)

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ABBREVIATIONS AND ACRONYMS

AWS	Amazon Web Services
AI	Artificial Intelligence
ARIN	Africa Research and Impact Network
CAN	Capacity Needs Assessment
CCAI	Climate Change Artificial Intelligence
GIS	Geographic Information System
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
ML	Machine Learning
NDCs	Nationally Determined Contributions
NGOs	Non-Governmental organizations
NLP	National Language Processing
R&D	Research and Development
STEM	Science ,Technology ,Engineering and Mathematics
UNITAR	United Nations Institute for Training and Research
UoN	University of Nairobi

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We extend our heartfelt gratitude to the numerous individuals and institutions for their engaging discussions and insightful feedback, which have significantly enhanced the outcomes and successful completion of this Capacity Needs Assessment Report on Leveraging Artificial Intelligence for Climate Resilience Solutions in Africa.
We sincerely appreciate the Africa Research and Impact Network (ARIN) for leading this crucial initiative, bringing together researchers, policymakers, and industry experts to assess the state of AI capacity for climate resilience in Africa.

We also extend our deep appreciation to the universities, faculties and students who participated in the survey, offering valuable feedback on the current state of AI education and the challenges faced within the academic and research communities. Their input has been instrumental in identifying the key barriers and opportunities for AI capacity development across Africa.

Furthermore, we acknowledge the crucial role of governments, industry leaders and policymakers in shaping the future of AI education in Africa. Their commitment to enhancing AI infrastructure, research and governance is vital in addressing the pressing socioeconomic challenges facing the continent.

A special thanks to the International Development Research Centre (IDRC) for its unwavering support in funding and facilitating this research. Their investment in AI driven climate resilience initiatives continues to empower African institutions to develop and implement sustainable, technology driven solutions.

EXECUTIVE SUMMARY

Artificial Intelligence (AI) is transforming industries worldwide, offering innovative solutions to pressing global challenges, including climate resilience, agriculture, healthcare, and energy efficiency. However, despite AI's potential to drive socio-economic development in Africa, its institutionalization in higher education remains limited. African universities face significant barriers in AI capacity development, including insufficient infrastructure, a shortage of skilled faculty, weak industry collaboration, inadequate policy frameworks, and a lack of locally relevant AI content. This report examines the current state of AI education in African universities, identifying key challenges and proposing strategic recommendations for capacity development and institutionalization.

A major challenge is the limited AI-focused training and capacity-building opportunities for faculty and students. The majority of institutions lack structured training strategies, with faculty requiring enhanced expertise in AI ethics, research methodologies, and pedagogy to update curricula and equip students with cutting-edge knowledge. Weak university-industry collaboration further limits students' exposure to real-world AI applications, with only a small percentage of institutions securing funding for AI labs or engaging in meaningful partnerships with the private sector. This impacts workforce preparedness, research relevance, and funding opportunities. Additionally, the lack of institutional AI governance and policy frameworks presents a significant barrier, as many universities operate without clear policies to guide funding allocation, curriculum development, and faculty recruitment. The absence of structured AI departments further exacerbates the problem, leading to fragmented efforts in AI education.

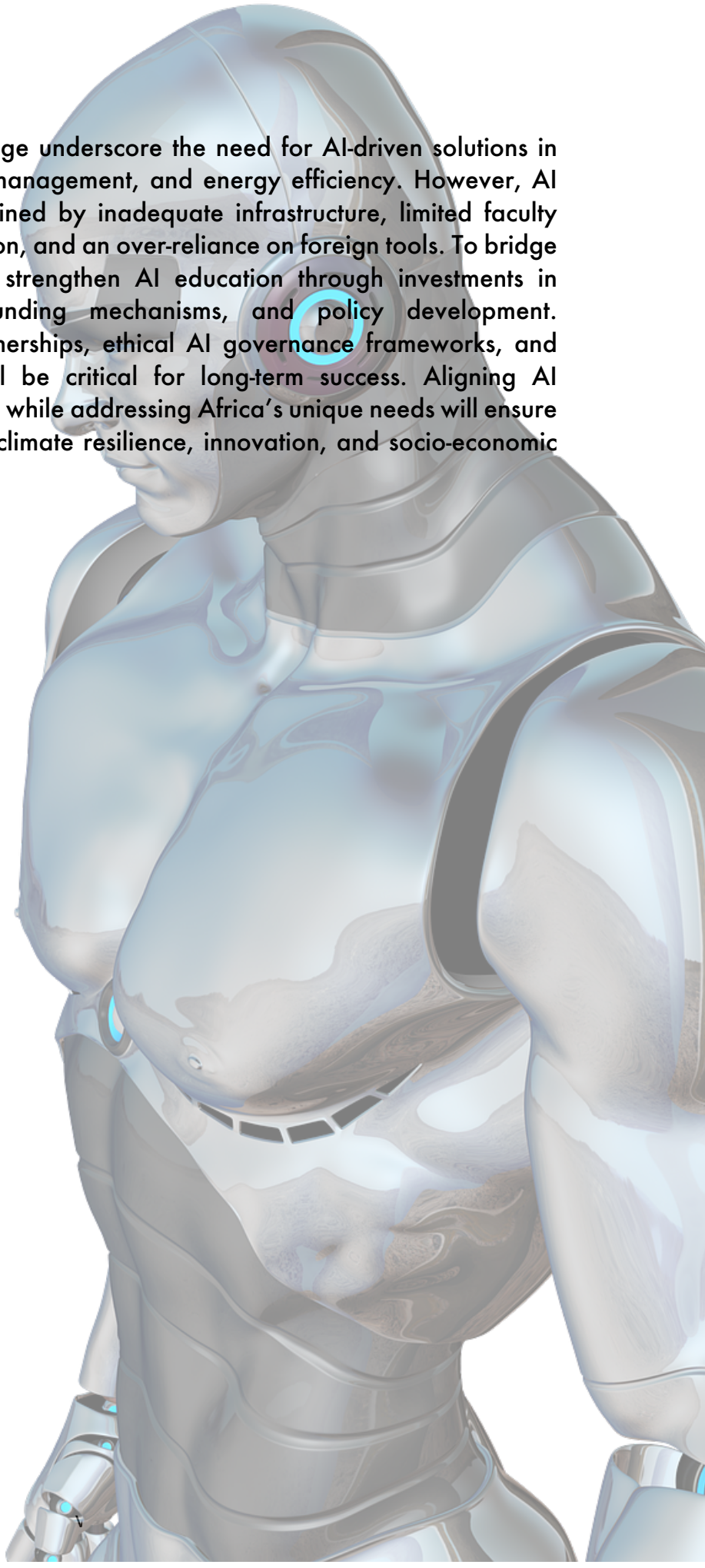
Ethical and societal concerns around AI deployment remain largely unaddressed. Algorithmic bias, data privacy issues, and potential misuse of AI raise concerns that require ethical training and governance structures. While institutions recognize the need for ethical AI education, few have concrete policies in place to ensure responsible AI use. AI remains confined to computer science and engineering departments in most universities, limiting its application in fields such as healthcare, environmental science, and social sciences. Despite growing recognition of the need for multidisciplinary integration, few institutions have developed strategies to embed AI across multiple disciplines. Another key challenge is the heavy dependence on foreign AI tools and content. Many universities lack locally developed AI teaching materials, making it difficult to address Africa's unique challenges in climate resilience, agriculture, and public health. Budget constraints further hinder access to AI tools and training resources, limiting the ability to develop localized AI solutions.

To overcome these challenges, African universities must adopt a holistic approach to AI education, focusing on infrastructure development, faculty training, sustainable funding, research culture, and curriculum reform. Strengthening AI infrastructure is crucial, with investments needed in high-performance computing, cloud platforms, and digital tools to support AI training. Improved internet connectivity and computing resources, particularly in rural and low-income institutions, will enhance AI accessibility. Faculty expertise should be expanded through structured development programs covering AI research, pedagogy, and ethics. Universities should facilitate faculty exchange programs with leading AI research institutions and provide continuous AI training workshops and certifications. Sustainable funding mechanisms must be developed by diversifying revenue sources beyond government allocations, leveraging private-sector investments, and securing international grants. Establishing AI innovation hubs can attract sponsorship and long-term financial sustainability.

A strong research and development culture is necessary to ensure AI contributes to both global advancements and local challenges. Universities should establish AI research centers, provide incentives for faculty and student engagement in AI research, and foster interdisciplinary collaboration. Regular updates to AI curricula are essential to keep pace with emerging fields such as deep learning, natural language processing, and AI ethics. University-industry collaborations should be strengthened to align AI courses with job market demands, ensuring students are equipped with relevant skills. Scaling AI-focused training programs, mentorship initiatives, and interdisciplinary learning opportunities will further enhance AI capacity development. Additionally, universities should develop AI governance and policy frameworks to regulate AI education and research. National AI policies should be formulated to integrate AI education into university programs, aligning with regional and global AI strategies. Collaborative efforts between governments, academia, and industry will be necessary to build a well-regulated AI ecosystem.

Addressing ethical and societal concerns is also crucial. AI curricula should include training on ethics, algorithmic bias, and data privacy, while AI ethics committees should be established to guide research and policy development. Public awareness campaigns on AI's societal impact will help address concerns about job displacement and data security. Promoting multidisciplinary AI integration will allow AI applications to extend beyond traditional fields, encouraging interdisciplinary research that can solve pressing societal challenges such as climate change, public health, and governance. Reducing reliance on foreign AI tools and content is also vital. Investing in the development of locally relevant AI curricula, strengthening local AI startups, and supporting African AI research hubs will drive indigenous innovation and adaptation.

The increasing risks of climate change underscore the need for AI-driven solutions in sectors such as agriculture, water management, and energy efficiency. However, AI adoption in Africa remains constrained by inadequate infrastructure, limited faculty expertise, weak industry collaboration, and an over-reliance on foreign tools. To bridge the gap, African universities must strengthen AI education through investments in infrastructure, faculty training, funding mechanisms, and policy development. Establishing university-industry partnerships, ethical AI governance frameworks, and multidisciplinary AI integration will be critical for long-term success. Aligning AI education with global advancements while addressing Africa's unique needs will ensure that AI contributes meaningfully to climate resilience, innovation, and socio-economic transformation in Africa.



1.0 INTRODUCTION

1.1 Background and context of the project

Climate change continues to present significant challenges across Africa, affecting ecosystems, livelihoods, and economies (IPCC, 2022). These impacts are particularly severe in countries that rely heavily on climate-sensitive sectors such as agriculture, water resources, and energy (Tofu et al., 2025). Disruptions in these sectors have far-reaching consequences (Uzoma et al., 2025). For instance, shifts in rainfall patterns, rising temperatures, and extreme weather events are causing crop failures, water scarcity, and increased frequency of disasters (Niang et al., 2014; Li et al., 2025). The direct impacts of climate change have profound implications for poverty, food security, and economic stability across the continent (Jain et al., 2023).

Several factors contribute to Africa's vulnerability to climate change. Over-reliance on climate-sensitive sectors, particularly agriculture, which employs the majority of Africa's population—heightens the risk for many nations (Doku et al., 2021a, 2021b; Phiri & Doku, 2024). Additionally, limited institutional, technological, and financial capacity constrains the ability of African countries to reduce emissions and build resilience against climate change (Oiganji et al., 2025). This challenge is exacerbated by a shortage of technical expertise and infrastructure, further hindering adaptation efforts and the development of innovative solutions to mitigate climate impacts (Mekonnen et al., 2021).

Regions such as Central, East, and West Africa are emerging as vulnerability hotspots, with some areas experiencing significantly higher mortality rates from climate-related events than less-affected regions (Olagunju et al., 2025). For example, climate-related mortality rates in high-vulnerability areas can be up to 15 times higher than in less-affected regions (Mbuvha et al., 2024). This stark contrast highlights the disproportionate impact of climate change on specific regions, with low-income and marginalized communities bearing the greatest burden.
National Adaptation Plans (NAPs) and Updated Nationally Determined Contributions (NDCs) from African countries emphasize the urgency of addressing these climate risks (Erbil, 2025). These documents highlight the rising costs and complexity of climate

challenges, warning that some damage may become irreversible if immediate action is not taken. Vulnerable populations, including women, children, and persons with disabilities, face heightened risks, as climate change exacerbates existing social and economic inequalities (Harmeling, 2018; Ozor et al., 2020; Webb, 2021).

1.2 The Role of Artificial Intelligence in Addressing Climate Change

The urgency to mitigate the impacts of climate change and build resilience across Africa necessitates innovative, scalable, and data-driven solutions. Artificial Intelligence (AI) offers immense potential in addressing these challenges, particularly through predictive analytics, real-time data processing, and evidence-based decision-making (Luu et al., 2025; Babatope, 2025). AI-based techniques are highly effective in analyzing complex climate datasets, forecasting future trends, and assessing climate-related risks (Karthikeyan, 2025; Indiazi, 2025). These technologies generate actionable insights to inform policy development and resource allocation to combat climate change (Cho & Ackom, 2025).

One of the key applications of AI in climate action is its ability to forecast carbon emissions based on current patterns. For instance, AI can predict how different industries or regions will contribute to carbon emissions in the future, enabling policymakers to design more effective mitigation strategies (Mardani et al., 2020). Additionally, AI can track carbon sequestration, providing crucial data to support strategies aimed at reducing atmospheric carbon levels (Menad et al., 2019). AI can also evaluate the feasibility and impact of major policy changes, allowing governments and organizations to assess the potential outcomes of various climate interventions before implementation (Pancholi & Shukla, 2025).

In Africa, where climate change impacts are particularly severe, AI presents a significant opportunity to enhance knowledge, response strategies, and adaptation efforts. AI-powered early warning systems for extreme weather events can improve preparedness and response at local, national, and regional levels. Furthermore, AI's ability to process and analyze vast amounts of data in real time enables more efficient decision-making, which is crucial for adapting to rapidly changing climate conditions.

1.3 Challenges in AI Implementation in Addressing Climate Change

Despite its potential, the implementation of Artificial Intelligence (AI) in addressing climate change in Africa faces significant challenges. One of the primary obstacles is the lack of skilled personnel to develop, deploy, and interpret AI models for climate modelling, resilience planning, and resource allocation. This skills gap stems from two key factors: limited AI-related training opportunities in Science, Technology, Engineering, and Mathematics (STEM) disciplines across Africa and a persistent gender disparity in the AI field. The underrepresentation of women in AI academia and the workforce further exacerbates this challenge, as limited mentorship and support structures hinder their participation in AI-driven climate solutions.

The scarcity of AI expertise in Africa is a critical barrier to its adoption for climate resilience. Governments and stakeholders across the continent struggle to develop inclusive and effective reporting frameworks for climate action, primarily due to a lack of reliable data and technical capacity to inform policy decisions. Additionally, the shortage of local AI experts makes it difficult to design context-specific AI models that address Africa's unique climate challenges and socio-economic realities. As a result, Africa risks falling behind in the global race to leverage AI for climate change mitigation and adaptation.

To overcome these challenges, strengthening AI capacity-building initiatives for early-career researchers, policymakers, and climate professionals is essential. Expanding AI training opportunities, particularly in climate science and policy, will enhance data-driven decision-making and strategic climate planning. Moreover, addressing gender disparities in AI is crucial for ensuring that women are equitably represented in the development and application of AI technologies for climate action. Implementing gender-inclusive policies and mentorship programs can help bridge this gap, empowering women to play a more active role in the AI and climate sectors.

1.4 The Leveraging Artificial Intelligence for Climate Resilience in Africa Project

The Leveraging Artificial Intelligence for Climate Resilience in Africa Project, implemented by the Africa Research and Impact Network (ARIN) and the University of Nairobi (UoN), is a critical and timely initiative aimed at addressing the challenges associated with AI adoption in climate resilience. This project seeks to harness the

power of AI to enhance adaptive capacities and mitigate climate-related risks across the continent.

1.5 Aim and Objective of the Project

1.5.1 Project Aim

The project aims to establish a strong foundation for AI-driven climate resilience in Africa. Through strategic partnerships and collaborative efforts, it seeks to bridge the skills gap, foster AI innovation, and ensure that AI solutions are tailored to Africa's unique climate challenges.

1.5.2 Specific Objectives

- **Enhance the capacity of early-career researchers to apply mathematical sciences and AI in climate action:** The project will provide training and mentorship opportunities in AI, climate modelling, and data science, equipping researchers with the necessary knowledge and tools to leverage AI for climate resilience.

- **Institutionalize AI and mathematical sciences within climate action frameworks:** By integrating AI and mathematical sciences into national institutions, universities, and research centres, the project will embed AI expertise into Africa's climate adaptation and resilience strategies, ensuring long-term impact.

- **Develop a network of AI specialists and champions for climate resilience:** The initiative will cultivate a cohort of AI professionals skilled in applying AI to climate science, enabling them to drive AI-powered climate solutions and contribute to evidence-based policy development.

2.0 CAPACITY NEEDS ASSESSMENT METHODOLOGY

2.1 Data Collection Approaches

The project focuses on establishing a robust framework for AI-driven climate resilience in Africa. By leveraging strategic partnerships and collaborative initiatives, it aims to bridge the skills gap, foster AI innovation, and ensure that AI solutions are tailored to Africa's climate-related challenges.

To identify knowledge deficiencies and curriculum enhancement needs in the fellowship program, a two-pronged capacity needs assessment was implemented. This involved rapid and targeted online surveys complemented by document reviews as a secondary data collection method.

The targeted survey was administered to over 200 ARIN Fellows (scholars and academicians at the MSc, PhD, and Postdoctoral levels) across 36 African countries, specializing in AI, climate science, and related fields. A broader needs assessment was also conducted through a rapid online survey, engaging policymakers, including government agencies and regulatory bodies, to ensure the institutionalization and implementation of AI-driven climate solutions.

Two sets of questionnaire surveys were administered:

1. The Capacity Needs Assessment (CNA) questionnaire evaluated participants' knowledge, skills, and institutional capacity in AI and climate resilience. It assessed AI proficiency, training needs, available resources, organizational involvement, barriers to AI adoption, and curriculum gaps. The assessment also explored institutional infrastructure, data accessibility, and interdisciplinary collaboration to identify key capacity-building and policy enhancement areas.
2. The Institutionalization Questionnaire Survey assessed the level of AI integration in African universities. It examined AI curricula, faculty expertise, research infrastructure, institutional policies, and industry partnerships, identifying training

needs, barriers to AI adoption, and strategies for institutionalizing AI skills. The goal was to enhance AI education, research, and policy alignment within African higher learning institutions.

The surveys were integrated into the Kobo Toolbox, with the link shared among key stakeholder groups. A pilot study was conducted with a small group of university faculty, researchers, and AI practitioners to pretest the questionnaires, ensuring clarity, relevance, and comprehensiveness. The questions were validated by aligning them with AI capacity-building objectives and expert feedback. Reliability was tested through consistency checks and refinements to enhance accuracy and replicability.

Additionally, secondary data analysis was conducted using policy documents, scientific reports, and institutional strategies to assess AI adoption for climate resilience. The review prioritized alignment with existing frameworks, identified gaps, and informed capacity-building needs. It encompassed a wide range of literature sources, including peer-reviewed journal articles, policy papers, and grey literature, to evaluate AI integration, capacity-building efforts, and the opportunities and challenges of implementing AI for climate resilience.

By synthesizing these insights, this study provides stakeholders with best practices and highlights areas requiring further development to enhance AI's effectiveness in addressing climate-related challenges.

2.2 Scope of Data Collection

The study incorporated multiple African countries across all regions—West Africa, East Africa, Southern Africa, and North Africa—ensuring regional representation and diverse perspectives.

Data collection focused on:

- AI curricula

- Research infrastructure
- Training programs
- Institutional strategies
- Interdisciplinary collaboration

Additionally, the study explored barriers to AI adoption, including funding constraints, limited expertise, and technology gaps. This comprehensive approach provided a robust foundation for identifying AI capacity gaps, opportunities, and recommendations for the institutionalization of AI in climate resilience efforts.

To ensure inclusivity across all regions of Africa, the survey tools were translated into French and Portuguese.

3.0 FINDINGS OF THE ASSESSMENT

3.1 Institutional and Human Capacity

3.1.1 Current Knowledge of Climate Resilient Concepts

Among the stakeholders mapped for the AI project:

- 38% demonstrated advanced knowledge of climate resilience concepts, primarily consisting of researchers, university faculty, and policymakers.
- 34% had moderate knowledge, including master's and PhD students, research assistants, and professionals in related fields.
- 18% possessed extensive expertise, mainly senior climate scientists and AI specialists.
- 10% had basic knowledge, representing early-career researchers, industry practitioners, and community-based stakeholders engaged in AI-driven climate resilience initiatives.

Additionally, 69.64% of respondents had experience working on climate resilience projects, while 30.36% did not. This distribution suggests that many stakeholders possess both theoretical understanding and practical experience in climate resilience, which is crucial for integrating AI and data-driven approaches into climate adaptation strategies in African projects.

However, the presence of stakeholders with limited experience highlights the need for targeted training and capacity-building initiatives to enhance engagement and effectiveness in climate resilience efforts (Figure 1).

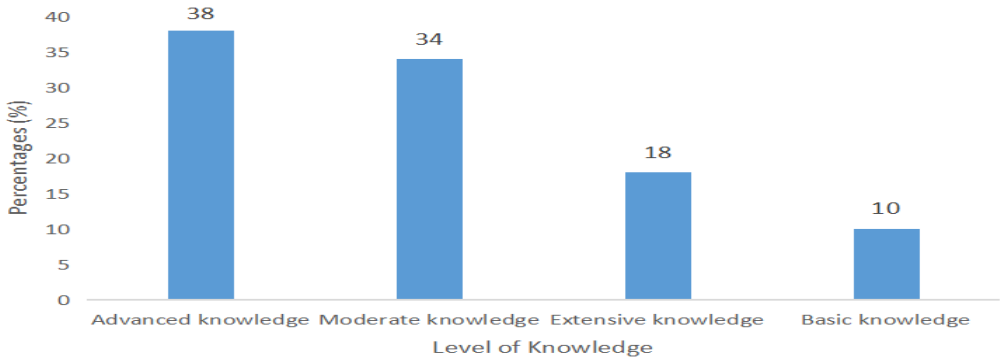


Figure 1: Current Knowledge of Climate Resilient Concepts

3.1.2 Availability of Artificial Intelligence and Machine Learning Programs

Among the survey respondents, 30.36% reported having programs in Artificial Intelligence (AI) and Machine Learning (ML), while 69.64% indicated that they do not offer such programs (Figure 2a).

Of the institutions that provide AI/ML programs, 25% (14 institutions) have integrated AI/ML into existing academic programs, whereas only 5.36% (3 institutions) offer standalone AI/ML programs (Figure 2b).

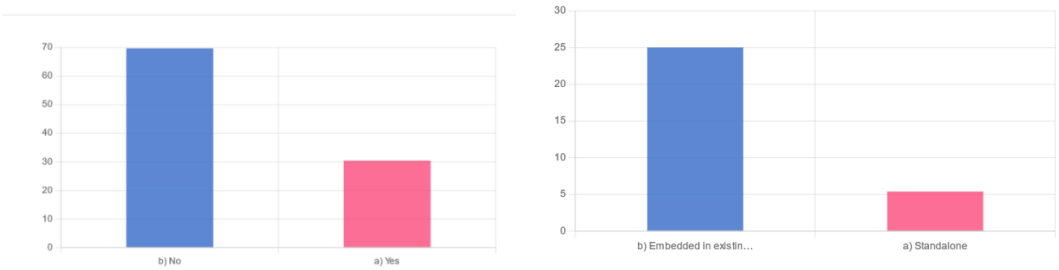


Figure 2a: Presence of AI and ML Programs in the Institutions; Figure 2b: Nature of AI and ML Programs

3.1.3 Participation in AI and Related Training Programs

Among the respondents, 70% reported that they had not taken any AI or related courses, while 30% indicated that they had participated in at least one AI-related course (Figure 3). The AI-related training programs attended by respondents covered a wide range of topics, including Machine Learning, Deep Learning for Computer Vision, and AI applications in land use and climate resilience.

Participants also acquired technical skills through training in Python, GIS, R, and Geospatial Artificial Intelligence (GeoAI). Additionally, capacity-building programs included AI for Educators, Climate Change AI, and AI for Public Health, alongside specialized sessions on supervised and unsupervised learning, data science, and AI-driven conservation strategies. Many stakeholders also engaged in virtual AI summer schools, mentorship programs, and workshops focusing on AI policy, curriculum development, and institutional capacity building.

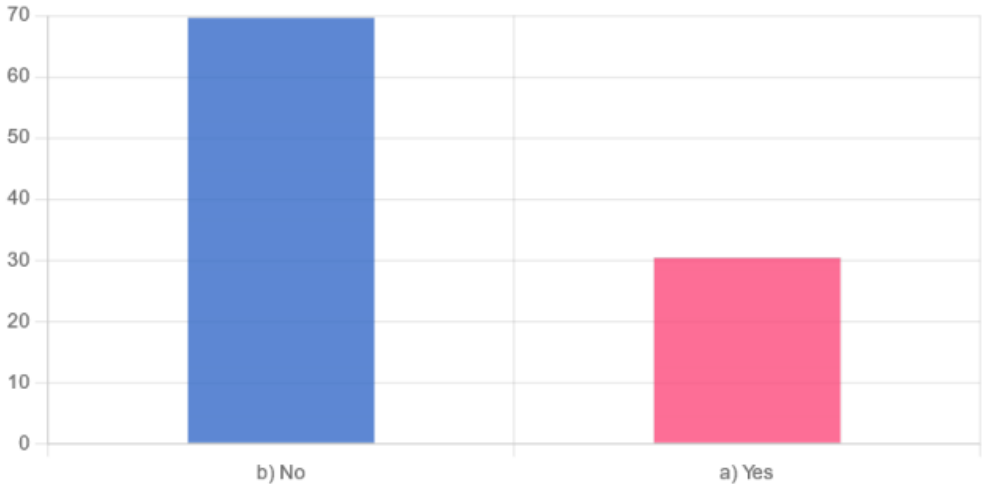


Figure 3: Participation in AI and Related Training Programs

3.1.4 Stakeholders' Level of Proficiency

Figure 4 illustrates the proficiency levels of stakeholders in key AI and climate resilience-related skills. Across all categories, more than 40% of respondents reported having no proficiency, particularly in mathematical modelling, machine learning, and deep learning. Basic proficiency levels ranged from 20% to 30%, while moderate proficiency was observed among 15% to 25% of respondents.

Advanced and high proficiency levels remained below 10% across all skill areas, highlighting a critical gap in expertise, particularly in deep learning and statistical methods. These findings indicate a significant skills deficit in AI and climate resilience fields across Africa. Addressing this gap requires targeted capacity-building initiatives

to enhance proficiency in machine learning, deep learning, and statistical methods, ensuring stakeholders are well-equipped to leverage AI for climate resilience solutions.

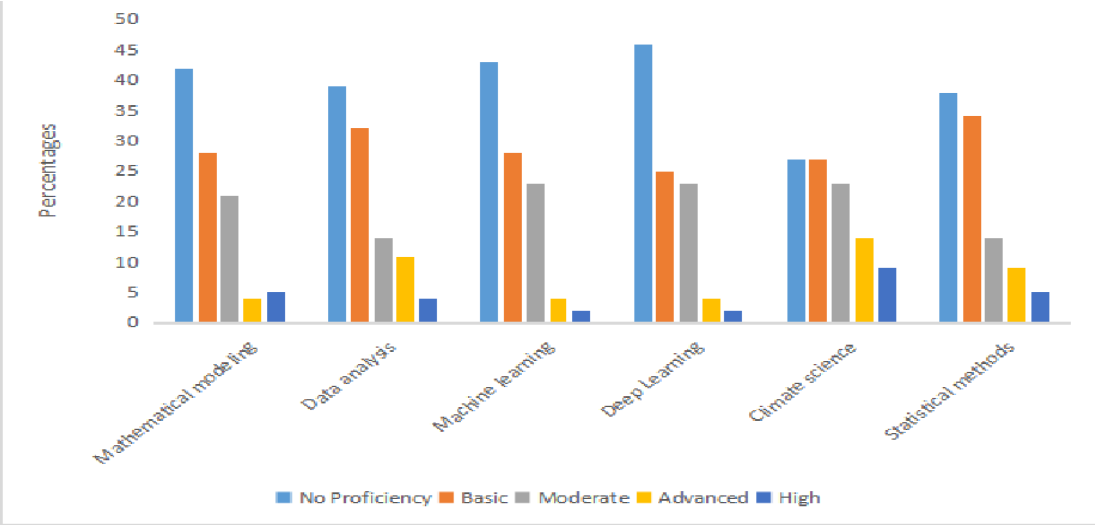


Figure 4: Stakeholders' Proficiency Levels

3.1.5 Level of Proficiency in Programming Languages

Figure 5 illustrates stakeholders' proficiency levels in programming languages relevant to AI. The findings indicate that 38% of respondents reported no proficiency, highlighting a significant gap in coding skills. Python and R, which are essential for AI and data analysis, were the most commonly known languages, with 35% of respondents demonstrating proficiency in each. In contrast, Java, MATLAB, and other languages had lower representation, each below 10%. While some stakeholders possess foundational programming skills, a substantial proportion lack the necessary expertise, posing a barrier to AI adoption for climate resilience. To bridge this gap, capacity-building initiatives should focus on enhancing proficiency in Python and R, ensuring stakeholders acquire the coding skills needed to effectively leverage AI technologies.

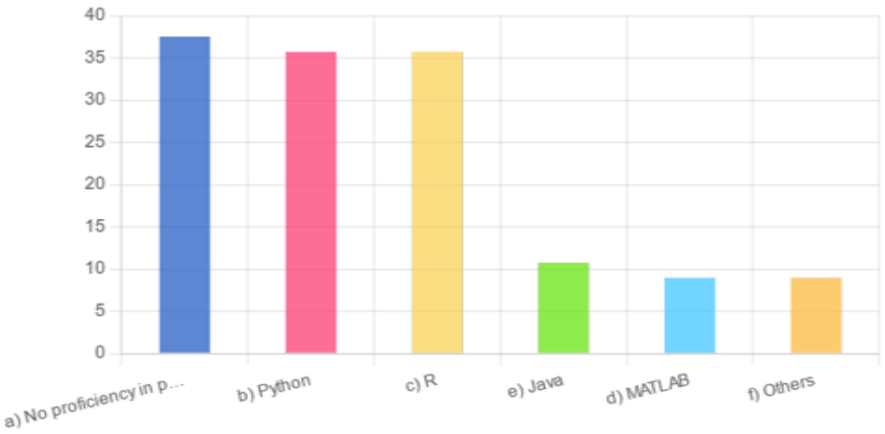


Figure 5: Level of Proficiency in Programming Languages

3.1 6 Training Programs and Opportunities

According to respondents, diverse training programs and continuing education opportunities exist to enhance skills and capacity in AI, machine learning (ML), big data analytics, and cloud computing as pertain to climate science and resilience. These include formal degree programs such as master's and postgraduate diplomas, as well as specialized short courses in data science, statistics, geographic information systems (GIS), and AI modelling.

Respondents noted that universities are increasingly offering interdisciplinary programs integrating climate science with information technology. Additionally, various workshops, boot camps, and online courses from platforms such as Coursera, edX, Alison, and Google Cloud Training provide accessible learning options. Institutions such as the Massachusetts Institute of Technology (MIT), Stanford University, and the Wangari Maathai Institute were cited as offering structured training and research opportunities.

Furthermore, international organizations, including the United Nations Institute for Training and Research (UNITAR), Climate Change AI (CCAI), and the International Institute for Applied Systems Analysis (IIASA), provide specialized programs focused on climate resilience. Cloud computing platforms such as Amazon Web Services (AWS)

and IBM Cloud for Sustainability also offer technical training tailored to environmental applications.

3.1.7 Areas Lacking in the Current Curriculum

Findings from the Capacity Needs Assessment (CNA) survey revealed significant skill gaps in the current curriculum, particularly in AI and machine learning techniques (94.64%), highlighting the urgent need to integrate AI-driven climate solutions. Additionally, advanced statistical methods (64.29%) and data visualization techniques (60.71%) were identified as critical deficiencies, emphasizing the importance of equipping learners with strong analytical and data interpretation skills.

The survey also highlighted gaps in climate policy and governance (55.36%), underscoring the need to bridge technical expertise with policymaking for effective climate resilience strategies. Furthermore, environmental economics (44.64%) emerged as a missing component, pointing to the importance of economic analysis in climate adaptation and sustainability efforts (Figure 6).

These findings suggest that enhancing AI, big data analytics, and interdisciplinary policy integration within the curriculum is essential to building capacity for climate resilience and informed decision-making.

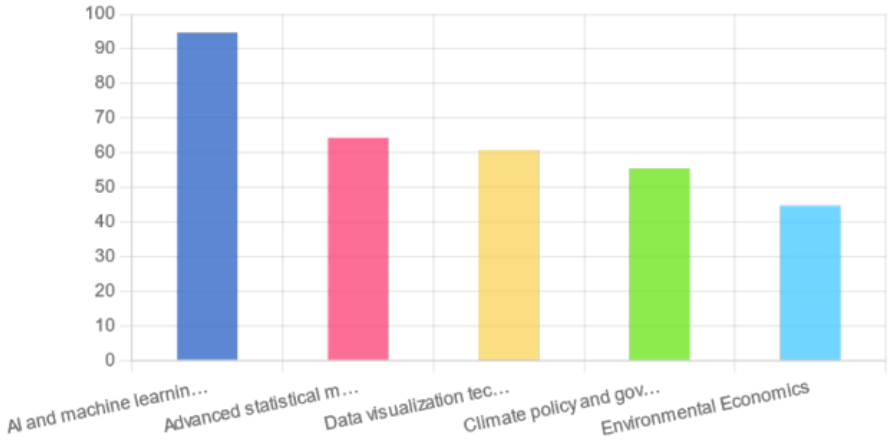


Figure 6: Key Areas and Topics Lacking in the Current Curriculum

The Capacity Needs Assessment (CNA) survey results indicate that the current curriculum lacks effective practical, hands-on experiences related to climate resilience. A significant proportion of respondents rated the curriculum as only slightly effective (37.5%) or moderately effective (30.36%), highlighting the need for greater emphasis on experiential learning (Figure 7). Additionally, 14.29% of respondents found the curriculum ineffective, further underscoring the gap in practical climate resilience training. While 10.71% of respondents considered it effective, only a small fraction (7.14%) rated it as very effective. These findings emphasize the necessity of strengthening the curriculum's practical components to enhance experiential learning and better equip students with real-world climate resilience skills.

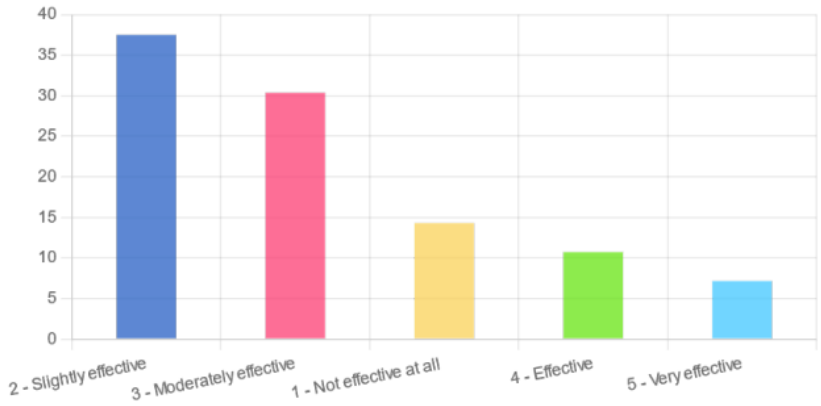


Figure 7: Incorporation of Practical, Hands-on Experiences Related to Climate Resilience in the Curriculum

3.1.8 Key Skills Needed for Effective Contribution to Climate Resilience Initiatives

Figure 8 summarises the key skills stakeholders need to develop further to contribute effectively to climate resilience initiatives. Climate modelling emerged as the most critical skill, with 89.29% of respondents identifying a need for improvement. This was followed closely by proficiency in machine learning algorithms (80.36%) and advanced statistical analysis (78.57%), underscoring the demand for technical

expertise in climate data analysis and predictive modelling. Additionally, 73.21% of respondents highlighted data visualisation as essential, reflecting the importance of translating complex climate data into actionable insights. Project management was also identified as a key area for skill development, with 64.29% of respondents recognizing its significance in coordinating climate resilience projects effectively.

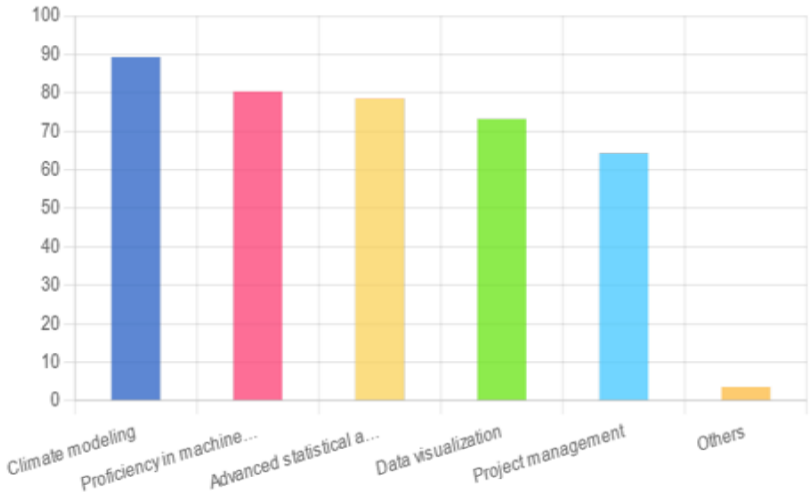


Figure 8: Key Skills Needed for Effective Contribution to Climate Resilience Initiatives

3.1.9 Practical Experiences to be Incorporated in the Curriculum

The CNA survey findings indicate that research projects (89.29%), workshops and seminars (83.93%), and fieldwork (83.93%) are the most prominent experiential learning approaches integrated into the curriculum. Case studies (69.64%) and internships (64.29%) are also included but to a lesser extent (Figure 9). While these methods provide valuable hands-on experience, the relatively lower emphasis on internships suggests a need for stronger industry linkages to enhance practical skills and improve job readiness.

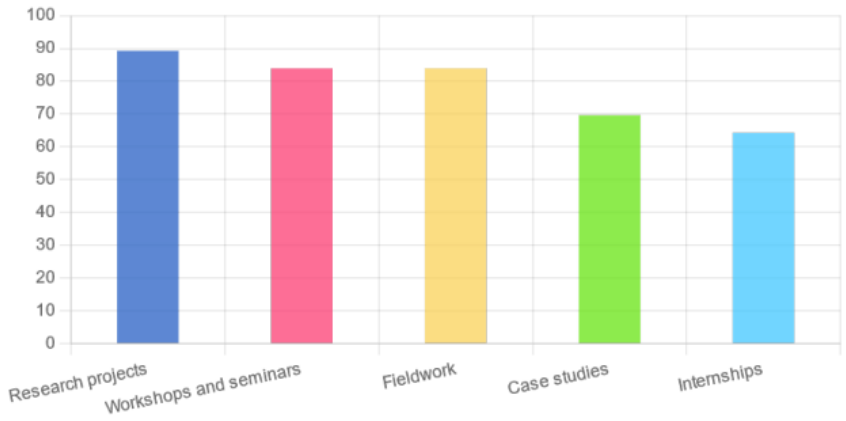


Figure 9: Practical Experiences to be Incorporated in the Curriculum

3.1.10 Enhancing University Support for Learning and Research in Climate Resilience

According to the respondents, universities can strengthen learning and research in climate resilience through several key initiatives. Financial support, including grants, scholarships, and student loans, is essential in enabling researchers to undertake critical studies. Expanding access to online courses, specialized training, and workshops on climate resilience and artificial intelligence (AI) can significantly enhance skill development.

Facilitating interdisciplinary collaboration, mentorship programs, and partnerships with industry and international institutions can create valuable opportunities for knowledge exchange and applied research. Investments in state-of-the-art facilities, such as AI labs, GIS tools, and high-performance computing infrastructure, can further enhance research capabilities. Additionally, organizing seminars, expert lectures, and academic field trips can help bridge the gap between theoretical knowledge and practical application.

Encouraging access to up-to-date research materials, promoting community engagement initiatives, and supporting conference participation can further enrich the academic experience. Universities can also advance climate resilience education by

integrating AI into curricula, fostering university-industry linkages, and supporting field-based learning opportunities.

3.1.11 Key Partnerships and Networks for Advancing AI Growth in Higher Education

Respondents identified several key areas for strengthening this initiative, including institutional growth through training, capacity building, financial and technical support, and research grants—both internally and by fostering an enabling environment for external funding. Strengthening networks among researchers, promoting interdisciplinary and multi-institutional collaborations, and establishing partnerships with government agencies, NGOs, and the private sector were also highlighted as priorities.

Additionally, engagement with international experts, climate-focused organizations, and open-source technology communities was deemed essential for advancing research and innovation. Collaborating with funding bodies, technology firms, and organizations specializing in climate resilience was emphasized as critical to securing resources, expertise, and essential tools.

Strategic partnerships play a pivotal role in climate resilience efforts, with 89.29% of respondents identifying NGOs as the most valuable collaborators due to their grassroots reach, advocacy, and implementation capacity. Academic institutions (82.14%) contribute critical research, data, and innovation, supporting evidence-based decision-making. Community organizations (80.36%) drive local engagement and ensure solutions are context-specific, while government agencies (78.57%) provide regulatory backing, policy alignment, and funding opportunities (Figure 10). The private sector (69.64%) brings financial investment, technology, and scalable solutions, though its engagement remains slightly lower.

A collaborative, multi-stakeholder approach that leverages these diverse actors is essential for driving impactful and sustainable climate resilience initiatives.

Figure 10: Partnerships and Networks for Advancing AI Education

3.2 Technical Capacity of Higher Learning Institutions

3.2.1 Training in AI or related disciplines

The data reveals that 77.78% of faculty members have received training in AI or related disciplines, while 11.11% have no training, and an additional 11.11% have foundational knowledge in AI-related areas (Figure 11). These findings highlight a significant skills gap, underscoring the urgent need for capacity-building initiatives to enhance AI expertise among faculty members. Strengthening AI-related training programs will be crucial in fostering research, innovation, and practical applications in climate resilience and sustainability.

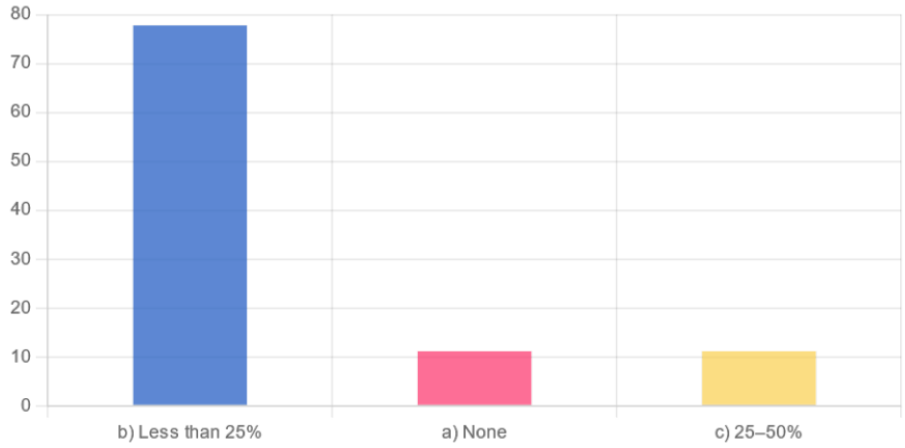


Figure 11: Faculty Members Trained in AI or Related Disciplines

The distribution of expertise levels varies across key disciplines, including mathematical modeling, AI and machine learning, data analysis, climate science, and stakeholder engagement (Figure 12). Notably, AI and machine learning have the highest proportion of novices (34%), highlighting a significant skills gap. In contrast, stakeholder engagement has the highest proportion of experts (32%), followed by climate science (27%). While mathematical modeling and data analysis exhibit a more balanced distribution across expertise levels, AI and machine learning require substantial capacity-building efforts to enhance proficiency beyond the novice and beginner stages. Strengthening AI competencies will be crucial for advancing interdisciplinary research and fostering practical applications in climate resilience.

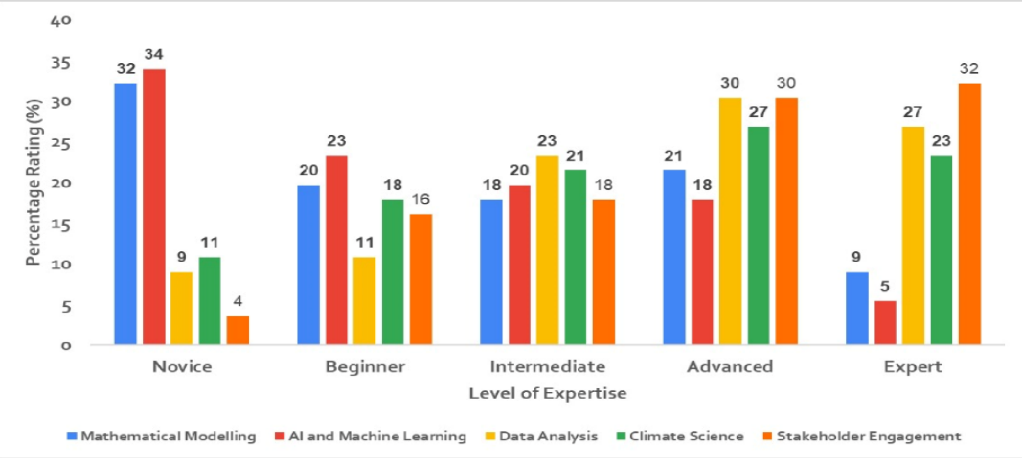


Figure 12: Distribution of Expertise Levels Across Disciplines

Survey results indicate low participation levels in AI-related professional development programs among staff in African universities. A significant portion (44%) reported never attending such programs, highlighting a critical gap in skill enhancement. Meanwhile, 33% participate once a year, and only 22% attend 2–3 times annually. These findings underscore the urgent need for expanded training opportunities and stronger institutional support to enhance AI expertise within African universities.

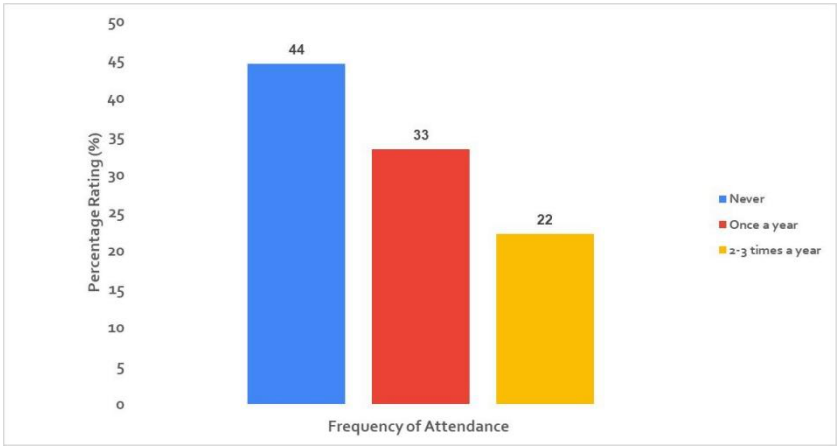


Figure 13: Frequency in Attending AI-related Professional Courses

3.2.2 Areas Researchers and Faculty Require Capacity Building

The most critical area for capacity building, identified by 100% of respondents, was training in AI research methodologies, emphasizing the need to equip faculty with the

skills necessary for conducting rigorous AI research. Additionally, 78% of respondents highlighted the necessity of technical skills, including programming and machine learning, as well as the ability to apply AI to address local and regional challenges, underscoring AI's role in tackling Africa's development needs (Figure 14).

Furthermore, 67% of respondents identified the need for pedagogical skills in teaching AI, reinforcing the importance of effective knowledge transfer to students. Ethical considerations in AI research and applications were highlighted by 66.67% of respondents, reflecting the growing need for responsible AI development and usage. Strengthening these capacity-building areas is essential for fostering a robust AI ecosystem within African universities, enabling faculty to drive research, innovation, and the responsible adoption of AI across various disciplines.

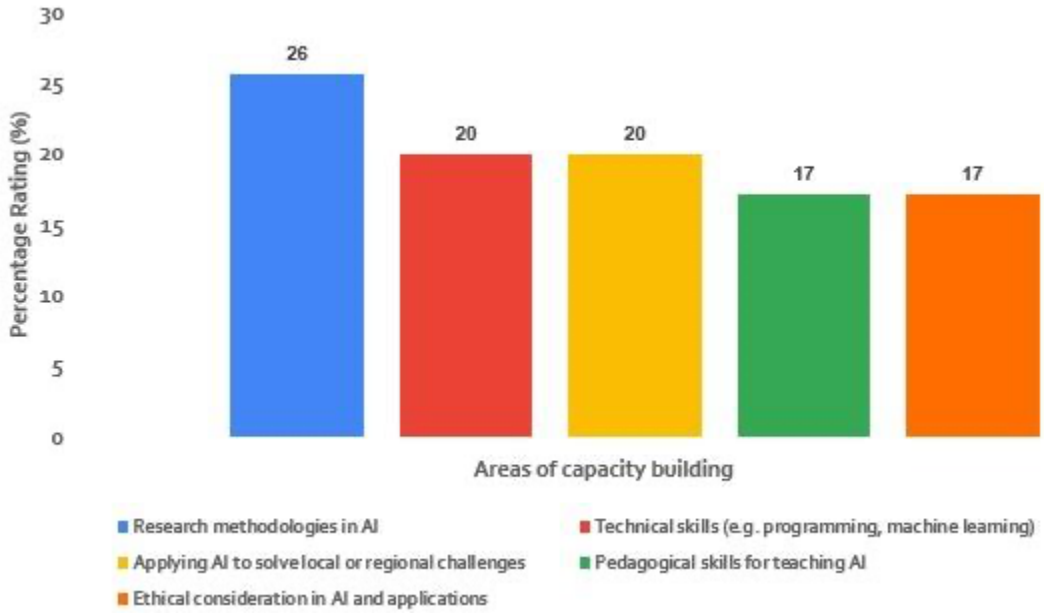


Figure 14: Areas of Capacity Building

3.2.3 Dedicated Strategy by Higher Learning Institutions for Staff Capacity in AI

Findings from the institutionalization survey revealed that 44% of respondents indicated their institution does not have a strategy for building staff capacity in AI. In comparison, 33% confirmed the existence of such a strategy, while 22% reported that a strategy is currently in development (Figure 15). These results highlight a significant gap in

institutional efforts to equip staff with AI-related skills, underscoring the need for more structured and widespread capacity-building initiatives to enhance AI adoption and integration.

According to respondents, the top institutional priorities for enhancing staff capacities in AI include training existing staff (32%) and hiring AI specialists (28%), demonstrating a strong focus on upskilling and recruitment. Establishing partnerships (22%) was also a key priority, suggesting a strategic effort to collaborate with external stakeholders. Meanwhile, investing in AI research (10%) and incentivizing interdisciplinary AI initiatives (6%) received lower prioritization. These priorities reflect a focus on immediate capacity building and workforce development, potentially at the expense of longer-term research and cross-disciplinary collaboration.

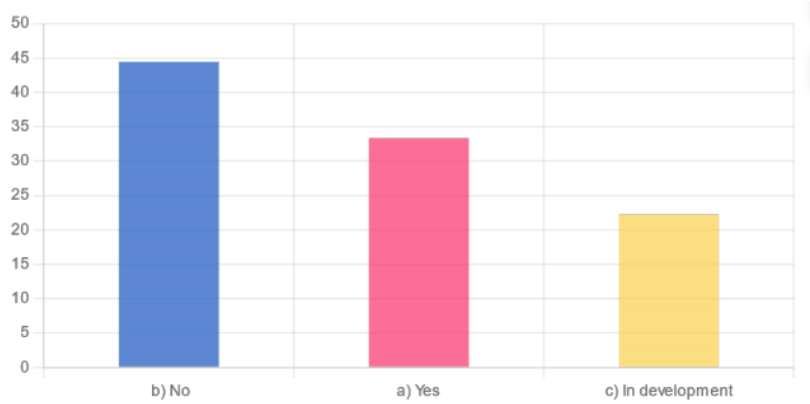


Figure 15: Dedicated Strategy by Higher Learning Institutions for Staff Capacity in AI

3.2.4 Adequacy of Current Infrastructure to Support Research in AI for Climate Resilience

Survey results indicate that the current infrastructure supporting AI research for climate resilience in universities is largely perceived as inadequate. A total of 35.71% of respondents rated it as inadequate, while 10.71% considered it insufficient. Additionally, 33.93% remained neutral, suggesting uncertainty or varied experiences. Only 14.29% found the infrastructure adequate, with a mere 5.36% rating it as highly adequate (Figure 16). These findings underscore the urgent need for increased

investment in AI research infrastructure to strengthen its role in advancing climate resilience efforts.

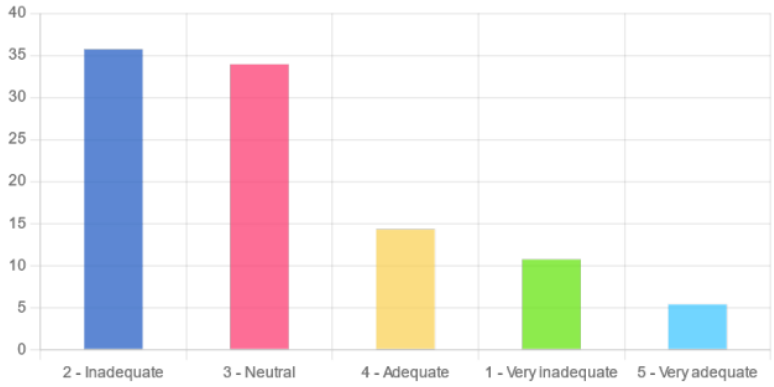


Figure 16: Adequacy of Current Infrastructure to Support Research in AI for Climate Resilience

3.2.5 Availability of Physical Resources for Climate Resilience Research

The availability of physical resources for climate resilience research presents both strengths and gaps. Libraries with climate-related resources are the most accessible, reported by 58.93% of respondents. Computing facilities, including high-performance computing, follow at 46.43%, while 42.86% of respondents confirmed access to data repositories. Additionally, 32.14% indicated the presence of dedicated research labs (Figure 17). However, only 7.14% reported access to other essential resources. These findings highlight the need for increased investment in specialized research laboratories and data infrastructure to enhance AI-driven climate resilience research.

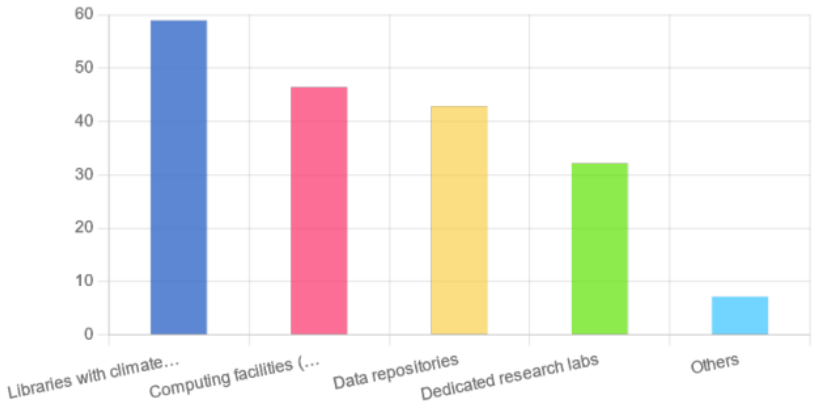


Figure 17: Physical Resources Available to Conduct Adequate Research

Respondents identified both challenges and opportunities in infrastructure and tools for climate resilience research at their universities. Many cited inadequate resources, outdated infrastructure, and limited access to advanced technologies such as AI, high-performance computing, and GIS tools. Critical gaps in funding (100%) and faculty expertise (100%) were unanimously highlighted, emphasizing the urgent need for financial and human resource investments in AI training and research.

Additionally, industry partnerships (80%) and computing infrastructure (65%) were noted as significant constraints, underscoring the necessity of stronger collaborations and technological capacity-building. While access to data (20%) was the least reported challenge, some respondents stressed the need for dedicated AI research centers, improved data accessibility, and interdisciplinary collaborations to bridge gaps between climate science and data-driven innovations (Figure 18).

Essential needs included field data collection tools, climate modeling software, and real-time data integration capabilities. Although some institutions have foundational support structures, strategic investments in infrastructure, digital tools, and interdisciplinary capacity-building remain crucial for advancing climate resilience research and AI development.

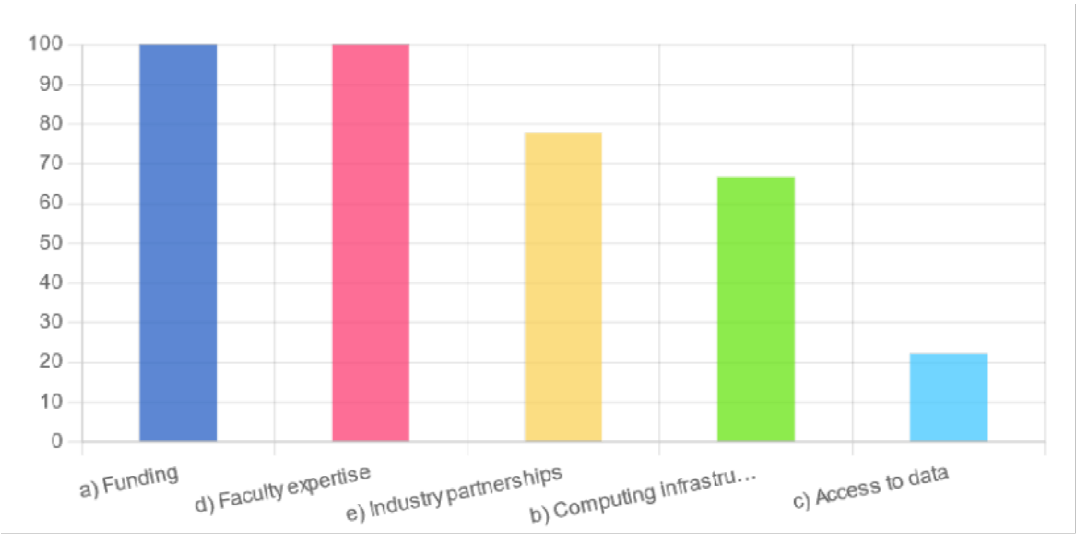


Figure 18: Resources Lacking for AI Training and Research

3.2.6 Training Opportunities for Using Infrastructure and Tools Related to Climate Resilience

The capacity-building landscape for AI-driven climate resilience research is diverse but unevenly distributed. Workshops are the most widely available training format, with 71.43% participation, demonstrating their effectiveness in providing hands-on learning. Online courses follow at 58.93%, offering flexibility and accessibility. Seminars and guest lectures, attended by 53.57% of respondents, provide valuable expert insights and networking opportunities.

However, more personalized learning approaches, such as one-on-one training sessions, are accessible to only 37.5% of respondents, indicating a gap in tailored mentorship. Additionally, just 3.57% reported access to other training formats, highlighting the need to diversify learning opportunities to foster a more inclusive and impactful capacity-building ecosystem(Figure 19).

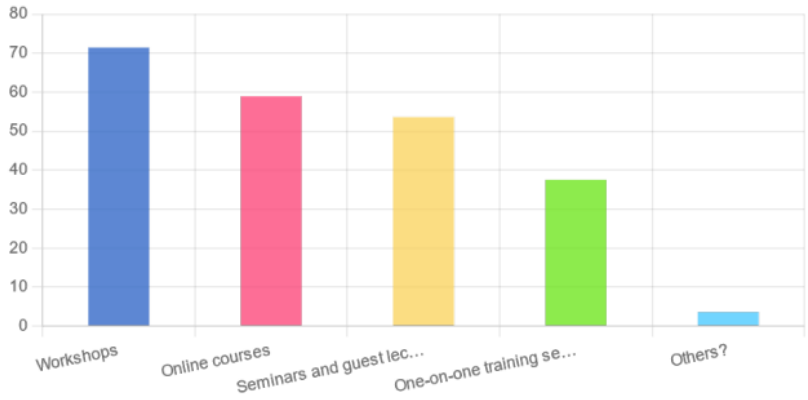


Figure 19: Available Training Opportunities

3.2.7 Actions Needed by Universities to Institutionalize AI

Survey responses concerning the actions necessary for African universities to institutionalize AI revealed key priorities. A majority of respondents (56%) emphasized the need to introduce AI as a cross-disciplinary subject across all fields, reflecting the importance of integrating AI into diverse academic disciplines. Recruiting and retaining top AI researchers and faculty was the second most frequently cited action, at 22%, underscoring the need for expert human resources.

Additionally, 11% of respondents pointed to the importance of developing accessible training programs for diverse communities, while another 11% highlighted the necessity of establishing funding channels for research and infrastructure (Figure 20). These findings indicate that African universities should focus on curriculum integration, faculty expertise, capacity building, and sustainable funding to effectively institutionalize AI.

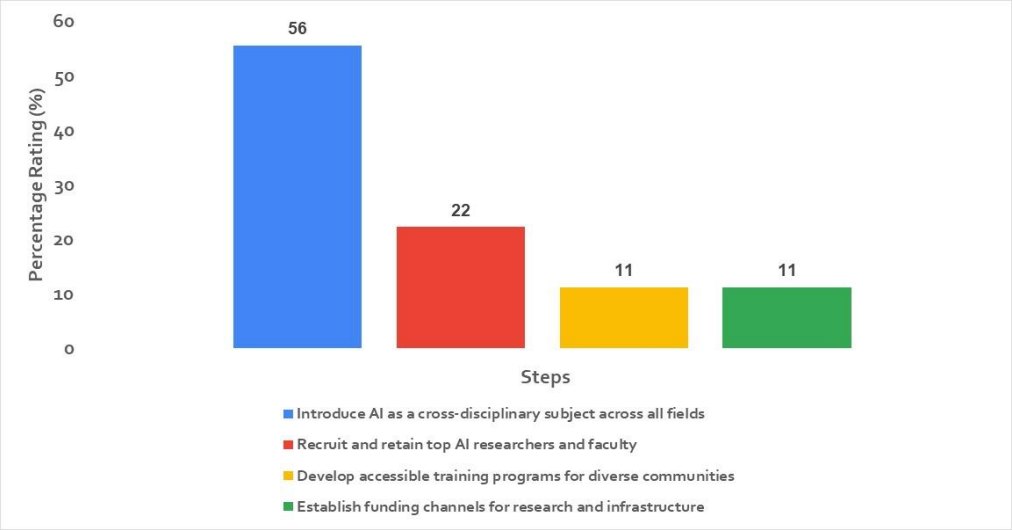


Figure 20: Steps to Institutionalize AI in Higher Learning Institutions

Survey responses regarding the institutionalization of AI in African universities highlighted key incentives essential for the long-term engagement of students and faculty. The most significant incentive, reported by 89% of respondents, was scholarships for AI-related studies, underscoring the critical need for financial support to increase accessibility and participation in AI education and research

Additionally, 78% of respondents underscored the importance of international collaborations, which facilitate global knowledge exchange, skill development, and exposure to cutting-edge AI advancements. Competitive research grants, identified by 67%, are crucial for funding AI-driven projects, enabling researchers to explore AI applications in climate resilience, biodiversity conservation, and sustainable development. Similarly, 67% of respondents highlighted the need for access to state-of-the-art labs and resources, recognizing the role of advanced computational tools and AI infrastructure in enhancing research and innovation.

These findings underscore that institutionalizing AI in African universities requires strategic investment in funding, expertise, and infrastructure to foster a robust AI ecosystem that supports research, innovation, and capacity-building.

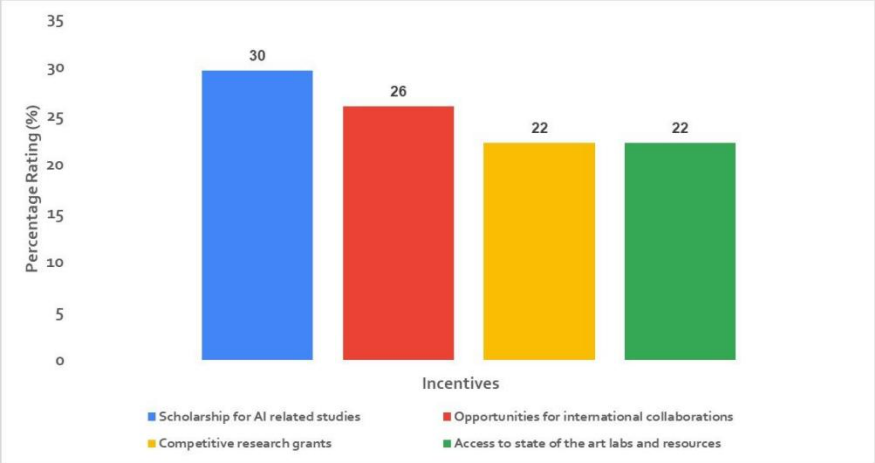


Figure 21: Incentives Essential for Long-Term Research

3.2.8 Partnerships to Enhance AI Research

Partnerships are crucial in institutionalizing AI in African higher learning institutions by fostering collaboration, knowledge exchange, and resource mobilization. Survey respondents unanimously acknowledged the importance of partnerships in advancing AI research and development.

The most preferred form of collaboration, cited by 41% of respondents, was joint research projects, underscoring the need for cooperative efforts to drive AI innovation. Guest lectures and training sessions conducted by industry experts followed at 28%, highlighting the significance of bridging academic learning with real-world industry applications. Additionally, 18% of respondents emphasized the necessity of funding for AI labs and research centres, which are crucial for building infrastructure and supporting AI advancements. Lastly, 13% advocated for internship programs, reinforcing the role of experiential learning in equipping students with practical AI skills (Figure 22).

Strengthening these partnerships will enable African universities to develop robust AI ecosystems, producing skilled graduates and impactful research that addresses both regional and global challenges.

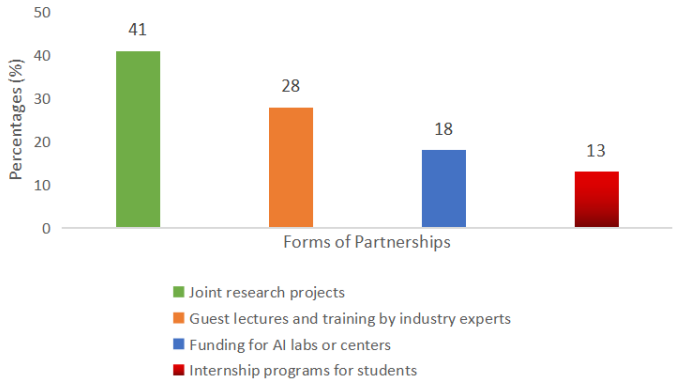


Figure 22: Partnerships to Enhance Institutionalization

3.2.9 Strategies to Institutionalize AI Effectively in African Universities

Institutionalizing AI in African universities requires strategic actions to integrate AI into academic and research frameworks effectively. Key priorities identified as critical for formalizing AI as a strategic institutional focus were supported by 79% of respondents, underscoring the need for universities to recognize AI as a vital area for investment and development. Likewise, 79% emphasized the necessity of AI governance structures within universities to establish transparent policies, oversight, and coordination of AI initiatives. Another 79% highlighted the importance of partnering with governments to align AI education with national strategies, ensuring policy coherence and integration into national development priorities. Additionally, 56% of respondents stressed the development of ethical guidelines for AI research and applications, reinforcing the need for responsible AI deployment. These strategies lay a strong foundation for the sustainable integration of AI into African higher education institutions, fostering innovation, skill development, and ethical AI use.

Universities play a crucial role in strengthening the research and innovation ecosystem by fostering academic and industry linkages that drive AI policy and development. The survey highlights that 78% of respondents recognized the importance of leading public awareness campaigns on AI benefits and risks, which can attract industry collaborations and funding opportunities. Similarly, 78% emphasized the role of universities in

providing policy recommendations based on research insights, ensuring that AI policies align with real-world industry needs and technological advancements. Additionally, 67% acknowledged that offering advisory services to governments and organizations enhances university-industry partnerships, bridging the gap between research and practical AI applications. Strengthening these linkages can help align research priorities with industry demands, reduce funding gaps by demonstrating AI's economic and social value, attract investments, and promote sustainable AI innovation across Africa.

4.0 GAPS AND BARRIERS TO AI ADOPTION FOR CLIMATE RESILIENCE IN AFRICA UNIVERSITIES

4. 1 Limited Infrastructure

The lack of adequate infrastructure for AI education and research in African universities, particularly in developing regions, is a significant barrier, as highlighted by respondents. A majority (65%) identified inadequate infrastructure as a major limitation, with many institutions lacking AI labs, computing resources, and advanced digital tools necessary for hands-on training. High-speed internet, computing power, and access to cloud platforms and AI development environments are often unavailable, further hindering AI education.

The digital divide exacerbates this challenge, particularly in rural or low-income regions, where institutions struggle to provide students with essential computing resources. Without modern infrastructure, implementing practical AI modules becomes difficult, weakening the effectiveness of AI courses. Additionally, the existing infrastructure in many universities is obsolete, making it harder to support interdisciplinary collaboration and AI-driven research.

Without substantial investment in infrastructure, universities will continue to struggle to create a conducive learning environment for AI development and innovation.

4. 2. Limited Faculty Expertise in AI

Integrating AI into curricula requires highly skilled instructors in AI, machine learning, and data science. However, in regions where AI research is still emerging, particularly in Africa, a significant shortage of AI-trained faculty poses a major challenge. Recruiting or training educators is costly and time-intensive, and many current instructors lack familiarity with rapidly evolving AI technologies, limiting their ability to deliver up-to-date content.

This gap affects curriculum design, alignment with global standards, and industry relevance. With 67% of respondents highlighting the need for expertise in AI research methodologies, pedagogy, and ethics, the shortage also limits mentorship opportunities and hands-on AI training.

4.3. Funding Shortages

Financial limitations severely constrain AI integration in African higher education, as most funding is allocated to recurrent expenditures such as salaries and operational costs rather than investments in infrastructure, research, and faculty development. Establishing AI programs requires substantial resources for high-performance computing, cloud services, and specialized training, yet universities struggle with inadequate budgets.

External funding from governments and private sector collaborations remains insufficient, with 100% of respondents identifying financial constraints as the most significant barrier. This lack of investment restricts faculty expertise, AI research centres, and access to essential tools, ultimately slowing Africa's innovation and capacity-building in AI education. Addressing these funding gaps requires strategic policies, increased government support, and strengthened partnerships with the private sector and international donors to ensure sustainable AI development in African universities.

4.4 Insufficient Research and Development Culture

A weak research and development (R&D) culture remains a significant barrier to AI institutionalization in African universities. Only 22.22% of institutions surveyed identified leading AI research and innovation as a priority, while 66.67% focused on building capacity through education and training. This suggests that many universities prioritize teaching over research, limiting their ability to contribute to AI-driven innovation.

Additionally, 77.78% of respondents noted the absence of a dedicated AI research center, constraining interdisciplinary collaboration and industry partnerships. Without strategic investments in AI research infrastructure and funding mechanisms, African universities will struggle to develop globally competitive AI programs.

4.5 . Rapidly Evolving AI Landscape

The rapidly evolving nature of AI, coupled with a weak research and development (R&D) culture, presents significant challenges for African universities. According to the survey, only 22% of institutions prioritize AI research, while 67% focus on capacity building through education, indicating a stronger emphasis on teaching rather than innovation. Additionally, 78% of universities lack dedicated AI research centres, limiting interdisciplinary collaboration and partnerships. Without substantial investments in research infrastructure, AI innovation will remain restricted, delaying the development of locally relevant applications and solutions.

Keeping AI curricula updated to match the field's rapid evolution is another major hurdle. While 100% of institutions recognize the need for regular curriculum updates, 89% face budget constraints, and 67% struggle with faculty shortages. These limitations hinder the ability to train students in emerging AI domains such as deep learning and natural language processing. The absence of structured funding mechanisms and strong industry collaborations further exacerbates the issue, making it difficult for universities to adapt AI programs to global standards and local needs.

4.6 Insufficient AI-Focused Training and Capacity Building

Limited AI-focused training and capacity building remain critical challenges in African universities, with 89% of respondents indicating insufficient training opportunities for faculty and students. While all respondents acknowledged that higher learning institutions recognize the need for faculty development, few have structured strategies

in place to address this gap. Additionally, 79% of respondents noted that staff require enhanced skills in AI ethics, research methodologies, and pedagogy. The lack of expertise among educators limits their ability to update curricula and equip students with cutting-edge AI knowledge, ultimately slowing innovation.

The absence of interdisciplinary training and industry collaboration further exacerbates the issue. Only 56% of respondents indicated that universities and higher learning institutions partner with industry or other organizations for AI training and research. Moreover, 67% of respondents noted that African institutions lack access to AI research infrastructure, while 100% cited funding constraints as a significant barrier to training initiatives. Without strategic investments in faculty development, industry collaborations, and sustainable funding, the institutionalization of AI skills in Africa will remain limited, hindering the continent's ability to develop a competitive AI workforce and research ecosystem.

4.7 Weak Industry Collaboration

Limited university-industry collaboration remains a significant barrier to AI institutionalization in African universities, as highlighted by survey respondents. Only 56% of respondents reported that their institutions had some form of industry collaboration, while 33% indicated they had engaged in guest lectures and training. Alarmingly, a mere 11% of respondents reported securing funding for AI labs, demonstrating the lack of structured partnerships.

This weak collaboration restricts students' exposure to real-world AI applications, internships, and job placements, ultimately affecting AI workforce preparedness. Furthermore, 78% of respondents emphasized the need for stronger industry linkages to sustain AI programs and align curricula with job market demands. The absence of active private sector engagement also limits funding opportunities, with 67% of respondents reporting no external funding support.

4.8 Lack of Institutional AI Governance and Policy Frameworks

The absence of AI governance and policy frameworks presents a significant challenge to institutionalizing AI in African universities, with 79% of respondents identifying it as a key barrier. Without clear policies to guide AI development, universities struggle with unstructured funding allocation, inconsistent curriculum development, and inadequate faculty recruitment strategies.

Only 22% of institutions surveyed have a dedicated department for AI research and training, underscoring the fragmented approach to AI education. Additionally, 78% of respondents emphasized the need for AI governance structures to streamline integration across disciplines, align AI education with national strategies, and support ethical AI development. Furthermore, 67% of universities reported a lack of partnerships with governments and industry to shape AI policies and funding mechanisms.

4.9. Ethical and Societal Concerns

Ethical and societal concerns remain critical barriers to AI institutionalization in African universities. 67% of institutions identified the need for training on ethical considerations in AI research and applications, including algorithmic bias, data privacy, and the potential misuse of AI. However, only 11.11% of institutions actively advocate for responsible AI use, highlighting the gap in structured ethical AI training.

This lack of dedicated ethical training leaves faculty and students underprepared to navigate real-world AI challenges. Furthermore, 78% of respondents emphasized the importance of developing ethical guidelines for AI research and applications, yet institutional frameworks remain weak.

4.10 Lack of Multidisciplinary Integration

The lack of multidisciplinary integration in AI education remains a critical challenge in African universities. 78% of respondents indicated that AI is still confined to computer science and engineering departments, limiting its application in fields such as healthcare, environmental science, and social sciences. This siloed approach reduces AI's overall impact and hinders its potential to address complex societal challenges.

A total of 56% of respondents acknowledged the need to introduce AI as a cross-disciplinary subject, yet only 22% reported having concrete strategies to integrate AI into broader academic programs. Additionally, 89% emphasized the importance of developing interdisciplinary research initiatives to ensure AI remains relevant to both local and global challenges. Strengthening multidisciplinary collaboration will be essential in fostering innovative, inclusive, and solution-driven AI research and education in African universities.

4.11 Global Dependence on Foreign AI Tools and Materials

African universities face a significant challenge in AI education due to their heavy reliance on foreign AI tools and curricula. 67% of respondents indicated that institutions lack locally developed AI teaching materials, limiting the contextual relevance of AI education. This dependence makes it difficult to tailor AI applications to address local challenges such as climate resilience, healthcare, and agriculture.

Additionally, only 22% of respondents reported having access to locally developed AI teaching resources, restricting opportunities for indigenous AI innovation. The challenge is further exacerbated by budget constraints, with 89% of respondents citing financial limitations as a major barrier to acquiring AI tools and training resources.

5.0 RECOMMENDATIONS FOR CAPACITY DEVELOPMENT AND INSTITUTIONALISATION OF AI IN LEARNING INSTITUTIONS

5. 1. Strengthening AI Infrastructure Development

A robust AI education ecosystem in African universities requires significant infrastructure investment. This includes high-performance computing, cloud platforms, and digital tools for hands-on AI training. Improving internet connectivity and computing resources, particularly in rural and low-income institutions, is crucial for bridging the digital divide. Universities must modernize outdated infrastructure through government funding, private-sector partnerships, and international grants to create conducive environments for AI-driven research and innovation.

5. 2. Expanding Faculty Expertise in AI

Developing faculty expertise is essential for integrating AI education into curricula. Universities should implement structured faculty development programs to enhance skills in AI research methodologies, pedagogy, and ethics. Faculty exchange programs with international AI research institutions, online AI certifications, and continuous training workshops should be prioritized to ensure instructors remain updated on evolving AI technologies.

5. 3. Enhancing Sustainable AI Funding Mechanisms

Enhance sustainable funding mechanisms to support AI programs. Universities should diversify their funding sources beyond government allocations by leveraging private-sector investments, international development grants, and industry collaborations. Establishing dedicated AI funding policies will ensure financial resources are directed toward infrastructure development, faculty training, and research support. Creating AI innovation hubs within universities can also attract sponsorship and funding from

technology companies and international organizations, fostering a self-sustaining AI ecosystem.

5. 4. Strengthening Research and Development Culture

A strong research and development (R&D) culture is essential for advancing AI education. Many institutions prioritize teaching over research, limiting AI-driven innovation. Universities should establish AI research centers to encourage interdisciplinary collaboration and partnerships. Additionally, incentives should be provided for faculty and students to engage in AI research, ensuring institutions contribute to global AI advancements while addressing local challenges.

5.5. Continuous Updating of the AI Curricula

AI curricula must be regularly updated to keep pace with the field's rapid evolution. Universities should create mechanisms for curriculum development directorates to work closely with industry and academia to revise AI courses. Emerging AI fields, including deep learning, natural language processing, and AI ethics, should be emphasized to ensure students receive relevant and practical AI training. Strengthening faculty capacity to continuously update curricula will help AI programs remain aligned with global advancements and local needs.

5. 6. Scaling and Strengthening AI-Focused Training and Capacity Building

Universities should scale AI-focused training initiatives for both faculty and students. Structured AI certification programs, mentorship initiatives, and interdisciplinary training opportunities will help bridge the skills gap. Collaborating with global AI education providers to offer affordable AI courses tailored to African contexts will enhance accessibility. Additionally, strengthening AI-focused mentorship programs will build a robust workforce equipped to tackle real-world AI challenges.

5.7. Enhancing University-Industry Collaboration

Stronger university-industry partnerships will provide students with practical AI exposure. Limited engagement restricts access to real-world applications, internships, and job placements. Establishing formal partnerships with AI-driven industries will ensure students gain hands-on experience, reducing the workforce readiness gap. Incentivizing private-sector investment in AI training programs will further increase financial support for AI education.

5.8. Developing AI Governance and Policy Frameworks

Developing AI governance and policy frameworks is crucial for institutionalizing AI in universities. Without clear policies, institutions struggle with unstructured funding allocation and inconsistent curriculum development. National AI policies should be formulated to integrate AI education into university programs, aligning curricula with national and regional AI strategies. Strengthening government-academia-industry collaboration will create a well-regulated AI education ecosystem in Africa.

5. 9. Addressing Ethical and Societal Concerns in AI

Universities must embed AI ethics, algorithmic bias, and data privacy into their curricula to promote responsible AI use. Existing ethics committees should guide AI research and applications, ensuring compliance with ethical standards. Additionally, institutions should lead public awareness campaigns to address societal fears about AI, including job displacement and ethical risks, fostering public trust in AI technologies.

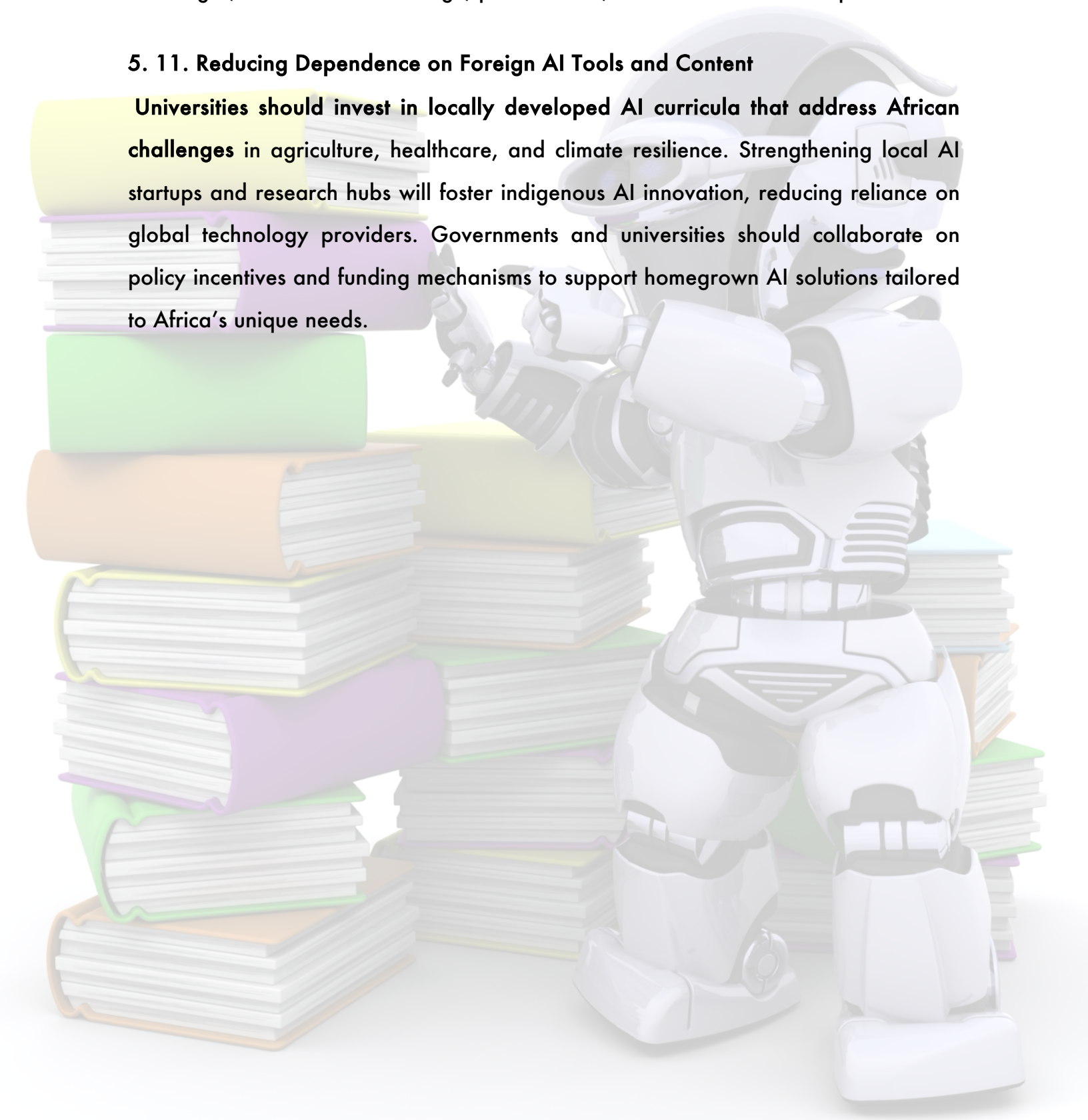
5. 10. Promoting Multidisciplinary AI Integration

To maximize AI's impact, universities must integrate AI across various disciplines. Cross-disciplinary AI courses should train students from diverse academic backgrounds, enabling AI applications in healthcare, climate science, governance, and other fields.

Encouraging interdisciplinary AI research projects will help solve pressing societal challenges, such as climate change, public health, and sustainable development.

5. 11. Reducing Dependence on Foreign AI Tools and Content

Universities should invest in locally developed AI curricula that address African challenges in agriculture, healthcare, and climate resilience. Strengthening local AI startups and research hubs will foster indigenous AI innovation, reducing reliance on global technology providers. Governments and universities should collaborate on policy incentives and funding mechanisms to support homegrown AI solutions tailored to Africa's unique needs.



6.0 CONCLUSIONS

The increasing risks of climate change threaten critical sectors such as agriculture, water resources, and energy, highlighting the urgent need for innovative, data-driven solutions. AI offers significant potential to enhance climate action through predictive analytics, real-time data processing, and informed decision-making. However, its adoption in Africa faces several challenges.

A major obstacle is the limited AI expertise among faculty and students, compounded by the absence of structured AI programs in many universities. This has led to a skills gap in machine learning, deep learning, and statistical methods. Additionally, insufficient infrastructure, including high-performance computing and cloud platforms, restricts AI's application in climate resilience.

The lack of AI governance frameworks further complicates AI integration, as many institutions lack policies to guide AI research, curriculum development, and funding allocation. Moreover, weak university-industry collaboration limits opportunities for internships, funding, and real-world AI applications. Universities also over-rely on foreign AI tools and content, reducing local innovation and adaptation to Africa's climate challenges.

Addressing these barriers requires strengthening AI infrastructure, expanding faculty training, securing sustainable funding, and fostering interdisciplinary research. Universities must enhance industry partnerships, establish ethical AI governance frameworks, and continuously update AI curricula. By aligning AI education with global advancements and Africa's unique climate resilience needs, institutions can unlock AI's full potential to drive sustainable solutions for climate adaptation and mitigation.

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8.0 ANNEXES

Annex 1: Capacity Needs Assessment Survey

LEVERAGING ARTIFICIAL INTELLIGENCE FOR CLIMATE RESILIENCE IN AFRICA

Introduction

The Africa Research and Impact Network (ARIN), in collaboration with the University of Nairobi, is conducting a Capacity Needs Assessment (CNA) to identify gaps and opportunities in skills, knowledge, and institutional frameworks necessary for effectively applying Artificial Intelligence (AI) to enhance climate resilience in Africa. This assessment is part of the Leveraging Artificial Intelligence for Climate Resilience in Africa project, which aims to build AI capacity in academia and policy spaces by strengthening and institutionalizing action-oriented skills among early career researchers and policymakers.

The main objectives of the project are to strengthen the capacities of early career researchers in applying AI for climate resilience in Africa, foster the institutionalization of AI skills and expertise for climate action, and cultivate a cohort of AI specialists proficient in leveraging AI to address climate change.

1.1 Personal Details

- **Name (Optional):** _____
- **Country:** ☐ Kenya ☐ Uganda ☐ South Africa ☐ Senegal ☐ Other (please specify): _____
- **Email Address:** _____
- **Phone Number:** _____

1.2 Academic and Professional Background

- **Position/Title:**

  ☐ Master's student

  ☐ PhD student

  ☐ Postdoc

  ☐ Research Assistant

  ☐ Other (please specify): _____

- **Field of Specialization** (e.g., Mathematics, Environmental Science, Computer Science, Engineering): _____

- **Year of Study:**

  ☐ 1st Year

  ☐ 2nd Year

  ☐ 3rd Year

  ☐ Other (please specify): _____

B. Capacity Needs: Current Knowledge and Skills

1. How would you rate your current knowledge of climate resilience concepts? (Select one option)

☐ **1** - No knowledge

☐ **2** - Basic knowledge

☐ **3** - Moderate knowledge

☐ **4** - Advanced knowledge

☐ **5** - Extensive knowledge

2. Have you taken any course or training in AI or related fields? (Select one option)

☐ **Yes**

☐ **No**

If yes, please specify the course(s) you have taken:_____

3. Rate your proficiency in the following areas:

(1 =No proficiency: 2=Basic proficiency: 3= Moderate proficiency, 4=Advanced proficiency: 5 =High proficiency)

Area	1	2	3	4	5
Mathematical modeling					
Data analysis					
Machine learning					
Deep Learning					
Climate science					
Statistical methods					

4. Which programming languages or tools are you proficient in? (Select all that apply)

☐ Python

☐ R

☐ MATLAB

☐ Java

☐ Other (please specify): _____

5. Have you worked on any projects related to climate resilience?

1. ☐ Yes
2. ☐ No

If yes, please briefly describe your project(s): _____

6. Have you applied AI techniques in any of your climate resilience projects?

1. ☐ Yes
2. ☐ No

If yes, what specific AI techniques have you applied in your projects?

7. Which skills do you feel you need to develop further to effectively contribute to climate resilience initiatives?

(Select all that apply)

☐ Advanced statistical analysis

☐ Proficiency in machine learning algorithms

☐ Data visualization

☐ Climate modeling

☐ Project management

☐ Other (please specify): _____

8. What types of training or workshops would you find most beneficial?

(Select all that apply)

☐ Machine learning applications

☐ Climate data analysis

☐ Mathematical modeling techniques

☐ Software tools (e.g., GIS, Python)

☐ Introduction to Artificial Intelligence and Machine Learning

☐ Deep Learning and Neural Networks

☐ Natural Language Processing (NLP)

☐ Computer Vision

☐ Ethics and Responsible AI

☐ AI and Big Data Analytics

☐ AI Programming and Tools (e.g., TensorFlow, PyTorch)

☐ Other (please specify): _____

9. What resources do you feel are lacking in your program that would assist in your studies related to climate resilience? (Open-ended)
10. How can your university better support your learning and research in this field? (Open-ended)
11. What are your career aspirations related to climate resilience? (Open-ended)
12. What role do you envision for AI in your future work in climate resilience? (Open-ended)

B. Institutional Capacity

1. What is your organization's current involvement in climate resilience initiatives?

(Select one)

☐ None

☐ Limited

☐ Moderate

☐ Extensive

2. Does your organization use AI technologies in your climate resilience efforts?

(Select one)

☐ Yes

☐ No

If yes, please describe how AI is applied in your climate resilience initiatives:

_____

3. What types of data does your organization currently utilize for climate resilience planning? (Select all that apply)

☐ Climate data (e.g., temperature, precipitation)

☐ Socioeconomic data

☐ Environmental data (e.g., biodiversity, land use)

☐ Infrastructure data

☐ Other (please specify): _____

3. What level of expertise does your organization have in the following areas? (Rate from 1-5, where 1= Novice, 2 = Beginner, 3 = intermediate, 4 = Advanced and 5 = Expert)

Area	1	2	3	4	5
Mathematical modeling					
AI and Machine Learning					
Data Analysis					
Climate science					
Stakeholder engagement					

5. What partnerships or networks do you believe are essential for fostering AI growth in your institution? _____-

6. What policies or strategies should your institution adopt to institutionalize AI skills effectively?

C. Curriculum Content

1. Does your institution have programs in Artificial Intelligence and Machine Learning?

☐ Yes

☐ No

If Yes, are the programs:

☐ Standalone

☐ Embedded within existing programs

2. How well does your current curriculum cover the following topics related to climate resilience? (choose only 1)

(1 = Not at all, 2 - Poorly, 3 - Moderately, 4 - Well, 5 - Very well 5 = Very well)

Area	1	2	3	4	5
Mathematical modeling for climate systems					
Data analysis techniques for climate data					
Machine learning applications in climate science					
Statistical methods relevant to climate research					
Interdisciplinary approaches to climate resilience					

3. What types of training programs or continuing education opportunities are available to enhance skills and capacity in AI, ML, big data analytics, and cloud computing related to climate science for climate resilience? _____

4. Which topics do you feel are lacking in your current curriculum? (Select all that apply)

☐ Advanced statistical methods

☐ AI and machine learning techniques

☐ Climate policy and governance

☐ Environmental economics

☐ Data visualization techniques

☐ Other (please specify) _____

5. How effectively does your curriculum incorporate practical, hands-on experiences related to climate resilience?

(1 = Not effective, 5 = Very effective)

☐ 1 - Not effective at all

☐ 2 - Slightly effective

☐ 3 - Moderately effective

☐ 4 - Effective

☐ 5 - Very effective

6. What types of practical experiences would you like to see more of in your curriculum? (Select all that apply)

☐ Internships

☐ Case studies

☐ Research projects

☐ Workshops and seminars

☐ Fieldwork

☐ Other (please specify) _____

7. To what extent does your program encourage interdisciplinary collaboration in addressing climate resilience?

(1 = Not at all, 5 = To a great extent)

☐ 1 - Not at all

☐ 2 - A little

☐ 3 - Moderately

☐ 4 - Considerably

☐ 5 - To a great extent

8. What disciplines do you think should be integrated into your curriculum to enhance learning about climate resilience? (Open-ended)
9. What are your organization's top three priorities for enhancing its capacity in mathematical sciences and AI for climate resilience? (Open-ended) _____
10. What support or resources would help your organization advance its climate resilience initiatives? (Open-ended) _____

D. Infrastructure and Tools

1. How adequate is the current infrastructure at your university for supporting research in AI for climate resilience?

(1 = Very inadequate, 5 = Very adequate)

☐ 1 - Very inadequate

☐ 2 - Inadequate

☐ 3 - Neutral

☐ 4 - Adequate

☐ 5 - Very adequate

2. What types of physical resources are available for conducting research in this area? (Select all that apply)

☐ Computing facilities (e.g., high-performance computing)

☐ Data repositories

☐ Dedicated research labs

☐ Libraries with climate-related resources

☐ Other (please specify) _____

E. Software and Tools

1. What tools or software does your organization currently use for data analysis and modeling? (Select all that apply)

☐ Excel

☐ GIS software

☐ Programming languages (e.g., MATLAB, Python)

☐ Statistical software (e.g., R, Python, SAS)

☐ AI/ML platforms (e.g., TensorFlow, PyTorch)

☐ Other (please specify): _____

2. How adequate are your current tools and resources for addressing climate resilience challenges?

☐ Very inadequate

☐ Inadequate

☐ Neutral

☐ Adequate

☐ Very adequate

F. Data Access and Management

5. How accessible is relevant data for climate resilience research at your university?

(1 = Not accessible at all, 5 = Very accessible)

☐ 1 - Not accessible at all

☐ 2 - Slightly accessible

☐ 3 - Moderately accessible

☐ 4 - Accessible

☐ 5 - Very accessible

6. What types of data are most readily available for your research? (Select all that apply)

☐ Climate data (temperature, precipitation, etc.)

☐ Socioeconomic data

☐ Environmental data (biodiversity, land use, etc.)

☐ Infrastructure data

☐ Other (please specify): _____

7. What training opportunities are available for using infrastructure and tools related to climate resilience? (Select all that apply)

☐ Workshops

☐ Online courses

☐ One-on-one training sessions

☐ Seminars and guest lectures

☐ Other (please specify): _____

8. How effective are these training opportunities in helping you utilize available tools and infrastructure?

(1 = Not effective at all, 5 = Very effective)

☐ 1 - Not effective at all

☐ 2 - Slightly effective

☐ 3 - Moderately effective

☐ 4 - Effective

☐ 5 - Very effective

9. How often does your organization collaborate with other stakeholders on climate resilience projects?

☐ Never

☐ Rarely

☐ Sometimes

☐ Often

☐ Always

10. What types of partnerships would be most beneficial for your organization to enhance climate resilience efforts? (Select all that apply)

☐ Academic institutions

☐ Government agencies

☐ NGOs

☐ Private sector

☐ Community organizations

G. Suggestions for Improvement

11. What additional infrastructure or tools would you suggest to enhance research capabilities in AI for climate resilience? (Open-ended)

12. Please provide any other comments or insights regarding the infrastructure and tools available for climate resilience research at your university: (Open-ended)

H. Barriers and Challenges

1. What are the main barriers your organization faces in leveraging AI for climate resilience?

(*Select all that apply*)

☐ Lack of funding

☐ Limited expertise

☐ Insufficient data

☐ Technology limitations

☐ Stakeholder resistance

☐ Other (please specify): _____

2. To what extent does a lack of expertise in your team impact your ability to implement mathematical and AI solutions for climate resilience?

(1 = Not at all, 5 = To a great extent)

☐ 1 - Not at all

☐ 2 - A little

☐ 3 - Moderately

☐ 4 - Considerably

☐ 5 - To a great extent

3. What specific areas of expertise do you feel are lacking in your organization? (Open-ended)

I. Data Challenges

4. How would you rate the quality of data available for climate resilience research?

(1 = Very poor, 5 = Excellent)

☐ 1 - Very poor

☐ 2 - Poor

☐ 3 - Fair

☐ 4 - Good

☐ 5 - Excellent

5. What data-related challenges do you encounter? (Select all that apply)

☐ Data scarcity

☐ Data quality issues

☐ Difficulty in data integration

☐ Lack of access to relevant datasets

☐ Other (please specify): _____

J. Technology Limitations

7. What technological limitations do you face when trying to implement AI solutions? (Select all that apply)

☐ Outdated software or hardware

☐ Lack of necessary tools or platforms

☐ Inadequate computational resources

☐ Other (please specify): _____

8. How effectively does your current technology support your research needs?

(1 = Not effective at all, 5 = Very effective)

☐ 1 - Not effective at all

☐ 2 - Slightly effective

☐ 3 - Moderately effective

☐ 4 - Effective

☐ 5 - Very effective

K. Collaboration and Engagement

9. To what extent do you experience challenges in stakeholder engagement and collaboration?

(1 = Not at all, 5 = To a great extent)

☐ 1 - Not at all

☐ 2 - A little

☐ 3 - Moderately

☐ 4 - Considerably

☐ 5 - To a great extent

10. What suggestions do you have for overcoming barriers and challenges in leveraging AI for climate resilience? (Open-ended)

Annex 2: Institutionalization of AI Survey
Institutionalization of AI Skills in African Universities

A. Status of AI in the Institution

1. Does your university currently offer AI-related courses or programs?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes, at what level are these courses offered? (Select all that apply):

- ☐ Undergraduate
- ☐ Postgraduate
- ☐ Professional/Executive education

2. Does your university have a dedicated department or center focused on AI research and training?

- ☐ Yes
- ☐ No

3. What percentage of faculty members are trained in AI or related disciplines?

- ☐ None
- ☐ Less than 25%
- ☐ 25–50%
- ☐ More than 50%

4. Does the institution have a strategy for building staff capacity in AI?

- ☐ Yes
- ☐ No
- ☐ In development

5. What should the institution prioritize to enhance staff capacity in AI?

(Rank from 1 to 5, with 1 being the highest priority)

☐ Hiring AI specialists

☐ Training existing staff in AI techniques

☐ Establishing partnerships with AI-focused organizations

☐ Investing in AI research infrastructure

☐ Incentivizing interdisciplinary AI projects

B. Infrastructure and Resources

1. Does your university have the necessary infrastructure to support AI research and training? *(e.g., high-performance computing, cloud services, specialized software)*

☐ Yes

☐ No

☐ Limited

2. What resources are lacking for effective AI training and research? *(Select all that apply)*

☐ Funding

☐ Computing infrastructure

☐ Access to data

☐ Faculty expertise

☐ Industry partnerships

3. Are there sufficient library or digital resources (e.g., journals, datasets, online courses) for AI education?

☐ Yes

☐ No

☐ Partially

C. AI Curriculum and Training Programs

1. Has your university developed a standardized curriculum for AI courses?

- ☐ Yes
- ☐ No

2. What areas of AI are currently included in your curriculum? *(Select all that apply)*

- ☐ Machine learning
- ☐ Natural language processing
- ☐ Computer vision
- ☐ Ethics in AI
- ☐ AI applications in local contexts *(e.g., agriculture, health, energy)*

D. Staff Capacity and Gaps

1. How many faculty members are trained to teach AI courses?

- ☐ None
- ☐ 1–5
- ☐ 6–10
- ☐ More than 10

2. What professional development opportunities are available for faculty to build AI expertise?

- ☐ None
- ☐ Limited
- ☐ Comprehensive

3. Have you received any formal AI training in the last five years?

- ☐ Yes
- ☐ No

4. If Yes, what types of training have you participated in? *(Select all that apply)*

☐ Short courses

☐ Online certifications

☐ Workshops or bootcamps

☐ Conferences

☐ Advanced degree programs (e.g., Master's or PhD in AI-related fields)

5. How frequently do you attend AI-related professional development programs?

☐ Never

☐ Once a year

☐ 2–3 times a year

☐ More than 3 times a year

6. Does the university collaborate with other institutions or organizations to train faculty in AI?

☐ Yes

☐ No

7. What specific steps should universities take to institutionalize AI in the long term? *(Select all that apply)*

☐ Recruit and retain top AI researchers and faculty

☐ Establish funding channels for research and infrastructure

☐ Develop accessible training programs for diverse communities

☐ Introduce AI as a cross-disciplinary subject across all fields

8. What incentives could encourage students and faculty to engage with AI in the long term? *(Select all that apply)*

☐ Scholarships for AI-related studies

☐ Competitive research grants

☐ Access to state-of-the-art labs and resources

☐ Opportunities for international collaborations

9. In which areas do staff members need capacity building to enhance AI expertise? *(Select all that apply)*

☐ Technical skills (e.g., programming, machine learning)

☐ Research methodologies in AI

☐ Pedagogical skills for teaching AI

☐ Ethical considerations in AI research and applications

☐ Applying AI to solve local or regional challenges

10. What barriers prevent staff members from accessing AI-related training? *(Select all that apply)*

☐ Lack of funding

☐ Limited time due to workload

☐ Insufficient training opportunities

☐ Lack of institutional support

11. What specific support do staff members require to enhance their AI skills? *(Select all that apply)*

☐ Access to training programs

☐ Opportunities for collaboration with AI experts

☐ Funding for AI research

☐ Availability of AI teaching materials

E. Collaboration and Partnerships

1. Does your university have partnerships with industry or other organizations for AI training and research?

☐ Yes

☐ No

If yes, what type of collaborations are in place? *(Select all that apply)*

☐ Joint research projects

☐ Guest lectures and training by industry experts

☐ Funding for AI labs or centers

☐ Internship programs for students

2. Are there any government or international initiatives supporting AI development at your university?

☐ Yes

☐ No

3. What challenges does your university face in developing or scaling AI-related programs? *(Select all that apply)*

☐ Lack of faculty expertise

☐ Inadequate student interest

☐ Budget constraints

☐ Lack of industry collaboration

☐ Other (please specify): _____

F. Policy and Strategy

1. Does your university have a formal strategy or policy for the development of AI skills?

☐ Yes

☐ No

☐ In development

2. What are the priority areas for AI institutionalization at your university? *(Rank from 1 to 5, with 1 being the highest priority)*

☐ Faculty training

☐ Student programs

☐ Research infrastructure

☐ Industry collaboration

☐ Policy advocacy

3. What policies or strategies should African universities adopt to institutionalize AI effectively? *(Select all that apply)*

☐ Formalizing AI as a strategic institutional priority

☐ Creating AI governance structures within universities

☐ Partnering with governments to align AI education with national strategies

☐ Developing ethical guidelines for AI research and applications

4. How can universities influence national and regional policies on AI development? *(Select all that apply)*

☐ Providing policy recommendations based on research insights

☐ Leading public awareness campaigns on AI benefits and risks

☐ Offering advisory services to governments and organizations

G. Long-term Vision

1. Where do you see the role of your university in advancing AI in Africa over the next 5–10 years? *(Select one)*

☐ Leading research and innovation

☐ Building capacity through education and training

☐ Facilitating industry and government collaboration

☐ Advocating for responsible and ethical AI

2. What key actions should your university take to institutionalize AI skills effectively? *(Select all that apply)*

☐ Invest in faculty development

☐ Develop specialized AI research centers

☐ Foster partnerships with industry and government

☐ Create accessible AI training programs for students and professionals

3. How can institutionalizing AI at your university contribute to national or regional development goals? *(Select all that apply)*

☐ Enhancing economic growth through innovation

☐ Addressing societal challenges (e.g., health, agriculture, education)

☐ Building Africa's global competitiveness in AI

☐ Promoting sustainable and inclusive development

4. In which sectors or domains do you envision your university making the most significant impact with AI research and training? *(Select all that apply)*

☐ Healthcare

☐ Agriculture and food security

☐ Climate change and environment

☐ Education

☐ Governance and public policy

5.What measures should be put in place to ensure the sustainability of AI programs at your university? *(Select all that apply)*

☐ Long-term funding mechanisms

☐ Ongoing faculty development

☐ Establishing strong industry partnerships

☐ Building robust research infrastructure

☐ Regular curriculum updates to match AI advancements

6. What mechanisms can help universities ensure the relevance of AI training to local and global challenges? *(Select all that apply)*

☐ Regular consultations with industry and government stakeholders

☐ Encouraging community-driven AI projects

☐ Developing interdisciplinary research initiatives

☐ Participating in global AI collaborations

H. Collaboration and Regional Leadership

1. How can African universities collaborate to advance AI education and research across the continent? *(Select all that apply)*

☐ Creating regional AI hubs or centers of excellence

☐ Sharing AI-related resources (e.g., datasets, faculty, infrastructure)

☐ Establishing pan-African AI research networks

☐ Hosting regional AI conferences or workshops

2. What role should African universities play in shaping global AI development and policies? *(Select all that apply)*

☐ Advocating for inclusive AI practices

☐ Contributing to global AI standards and frameworks

☐ Showcasing AI innovations addressing African challenges

☐ Partnering with global institutions for knowledge exchange

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