



Climate finance and sustainable banking in Tanzania (2020-2024): Emerging roles of AI, mitigation strategies and regulatory developments - a literature review

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ABSTRACT

Despite the growing importance of implementing climate finance and mitigation strategies within Tanzania's banking sector, particularly regarding the emerging role of Artificial Intelligence (AI), the supporting regulatory frameworks remain under-researched and insufficiently documented. This paper reviewed the state of climate finance and mitigation strategies, including the application of AI within the banking sector from 2020 to 2024. The study adopted a qualitative approach by synthesizing data from a comprehensive literature review that included published annual reports from 44 licensed banks in Tanzania (2020–2024), as well as grey literature such as policy documents, regulatory guidelines, and global development reports. The analysis is theoretically grounded in the Technology Acceptance Model (TAM) for AI adoption and institutional theory for regulatory and isomorphic pressure, providing a structured lens for evaluating sustainable banking practices. The findings indicate that there is a shift in the banking sector, with Tier 1 banks leading in green finance product innovation and AI-driven risk assessment, while mid-tier institutions focus on digital infrastructure and compliance. The banking sector in Tanzania, especially CRDB Bank and NMB Bank, is making a lot of progress in climate finance. CRDB Bank has secured substantial Green Climate Fund (GCF) financing for climate-resilient agriculture and has also launched a Green Bond Initiative (USD 300 million). On the other hand, NMB Bank has committed significantly to sustainability strategies and climate actions. The bank launched Jamii Bond (TZS 400 billion) in 2023. Additionally, these efforts are supported by regulatory guidelines developed by the Bank of Tanzania (BoT), which promotes and guides the incorporation of climate-related financial risks into banking operations. Despite the progress achieved, a finance mobilization gap remains, as only 3.6% of targeted climate finance was achieved by 2020, and the projected funding gap of USD 60–70 billion is anticipated by 2025, highlighting both challenges and opportunities for AI integration in bridging these gaps. The paper concludes that the Tanzanian banking sector plays a crucial role in supporting climate change financing and mitigation strategies. For this role to be effectively enhanced, capacity building in AI and climate finance analysis and innovative product development and strategic partnership are very essential to mobilize and access domestic and international resources. Improve transparency, and foster AI-driven climate-resilient growth for sustainable development.

Keywords: Artificial Intelligence, Banking Sector, Climate Adaptation, Climate Finance, Mitigation Strategies, Tanzania

I. INTRODUCTION

Climate change poses significant risks to the economic stability (Bank of Tanzania [BOT], 2025). This can result into both, transition and physical risks which may affect the safety and soundness of financial institutions, including banks, and at the end will impacting the overall financial stability (Haron et al., 2020). In this context, climate finance refers to the financial resources that are mobilized to support climate actions with the objective to mitigate the effects of climate change, to reduce vulnerability and also increases the resilience of human and ecological systems to negative impacts of climate change (Khatibu et.al., 2022). Climate finance is essential in mobilization of investments for environmentally sustainable projects including renewable energy, energy efficiency, green infrastructures, which will help in achieving the low-carbon, climate-resilience development (Flammer, 2020; World Bank, 2021). The banking sector is increasingly recognized as a key engine for climate actions, utilizing financial instruments in supporting both public and private initiatives (Haron et al., 2020; United Nations Environment Programme [UNEP] Finance Initiative, 2020).

Globally, major banks and large investment firms are actively making efforts in financing renewable energy projects, sustainable infrastructure by utilizing financial tools such as green bonds, sustainable investments and adopting sustainable financing frameworks (Nasir & Ahmed, 2024). Major international banks such as HSBC Bank, Citigroup and Goldman Sachs have committed to investing in billions of dollars in sustainable projects and initiatives. They are increasingly setting Net Zero targets to reduce their carbon footprints (Idowu et al., 2023). On the other hand, climate finance is increasingly being incorporated into Environmental, Social and Governance (ESG) frameworks (Nasir & Ahmed, 2024). Despite these achievements, transition and physical risks relating to climate change continue to pose significant challenges to global financial stability (Haron et al., 2020).



The banking sector has started to acknowledge AI as a revolutionary force in climate finance mechanisms and strategies. It has been remarkably applied in enhancing risk management by improving efficiency, data analysis, and predictive capabilities in the assessment of climate risks (Doddipatla, 2023; Tkachenko, 2024; Xu et al., 2024). Machine learning techniques are being actively employed in climate finance so as to conduct a thorough climate risk assessment (Tian et al., 2025). Moreover, AI tools enhance the assessment of ESG issues, allowing banks to identify valuable green investment opportunities and mitigate the associated transition and physical risks (Elias et al., 2024). In terms of green credit allocations, AI algorithms and predictive analytics enable financial institutions to optimize resource allocation, evaluate sustainable investments, and also develop financial solutions that comply with the ESG standards and regulations (Alshahmy & Sahiner, 2024; Elias et al., 2024). Fintech solutions which are usually empowered by AI, play a crucial role in development of finance models, offering investment services and loan programs that are environmentally friendly (Gupta et al., 2025). AI and big data analytics improve decision making in climate finance by assessing and forecasting environmental impacts of the funded projects, thus integrating ESG data for proper reporting, and improving the investment strategies (Olanrewaju et al., 2024). AI integration in sustainable finance is widely expanding globally, with countries in regions like Africa, and particularly Tanzania, utilizing Fintech for these advancements (Ally et al., 2025). This change, which has been driven by AI algorithms and predictive analytics, allows financial institutions to optimize resource allocation, assess sustainable investments, and also create innovative financial products in compliance with ESG standards and regulations (Alshahmy & Sahiner, 2024). The integration of AI and sustainable finance enhances data-driven insights for more impactful sustainable investments as well as improving risk management capabilities (Elias et al., 2024).

In Sub-Saharan Africa (SSA), climate finance is still highly needed due to the region's increased vulnerability to impacts from climate change despite emitting comparatively low greenhouse gas levels (World Bank, 2020). The impacts include droughts, floods, and the shifts in agricultural normal practices (Gemayel et al., 2025). The banking sector is progressively incorporating risks related to climate into decision making processes, and also allocating resources to support projects aimed at sustainable development and resilience (Haron et al., 2020; African Development Bank [AfDB], 2022). In practice, this is evidenced by financial institutions, like Standard Bank and Ecobank, which are now actively exploring green bonds and sustainable finance (Raman et al., 2024). Although climate finance flows in SSA have grown, it is still necessary to enhance greater investments in mitigation and adaptation (Gemayel et al., 2025). In this context, AI-driven tools offer new opportunities by optimizing green finance applications, enhancing risk assessments, and improving the reporting and monitoring of sustainable projects, which will promote a transparent and resilient climate finance ecosystem across the region (Alshahmy & Sahiner, 2024).

In East Africa, climate finance and mitigation strategies are becoming even more important as the region faces severe droughts, unpredictable rainfall, and rising sea levels (Gemayel et al., 2025). Banks such as KCB Group and Equity Bank are financing renewable energy, energy efficiency, and climate- resilient agriculture initiatives. Mobilization of climate finance remains a challenge in developing countries, as limited access to long-term funding and insufficient knowledge and skills on climate risk hinders the processes (Ackerl et al., 2023; Gemayel et al., 2025). Countries such as Kenya have launched climate bonds to attract sustainable investment, although the full potential of these efforts remains unfulfilled, highlighting the need for enhanced collaboration among stakeholders (Wang et al., 2024). Utilizing AI and other advanced analytics can help to bridge the knowledge gap, which will allow banks to more feasibly assess projects, predict climate impacts, and optimize resource allocation, thereby increasing the effectiveness of the climate finance initiatives throughout the region (Haron et al., 2020).

Climate finance flows to East Africa account for only 5% of the global total allocated to developing nations, with Kenya being the primary beneficiary from 2013 to 2018 (Khatibu et al., 2022). Most of these funds are sourced from bilateral agencies and are mainly distributed as loans, with only a small share as grants or equity (Khatibu et al., 2022), focusing on agriculture, forestry, land use, water and sanitation. The adaptation of data analysis enabled by AI and digital financial platforms can help in assessing and identifying funding gaps, ensure targeted investments, and improve transparency in fund distribution. This enhances the impact of the funding distributed (Mitra et al., 2022; Alshahmy & Sahiner, 2024; Ozili, 2025).

The economic impacts of climate change in Tanzania are very significant, with weather related disasters such as floods and droughts causing losses (World Bank, 2024). Events like the 2018 floods in Dar Es Salaam resulted in losses amounting up to 4% of the city's GDP (Erman et al., 2019). These costs are expected to rise if the climate change effects are taken as business as usual, thus threatening economic growth and poverty alleviation initiatives by stakeholders. Mitigation strategies that are expected to minimize the climate impacts require significant financial resources, which is a major challenge especially in developing countries (John, 2022). AI-powered models, and early warning systems offer a proactive strategy for banks and regulators in facilitating real-time risk assessment, which will enhance resource allocation and the development of customized financial solutions (Abrahams et al., 2023). CRDB's Bank's annual report highlights AI pilots for agricultural risk modeling (CRDB Bank, 2024).

Among the strategies to respond to the impacts of climate change globally, Tanzania has developed policies and strategies to address climate change impacts, including the National Climate Change Response Strategy, the National



Adaptation Plan, and updated environmental policies (Pauline & Lema, 2024). These activities align with the nation's Nationally Determined Contributions (NDC), and are also supported by the emerging climate finance in the country. The financial institutions are currently making efforts in incorporating climate risks into their lending and investment strategies, and they are also adopting green banking practices despite the ongoing challenges in capacity, regulations, and access to international funding (Rahman et al., 2022; Saif-Alyousfi & Alshammari, 2025). The AI integration into these frameworks can facilitate monitoring and reporting of the progress towards the national objectives, assess the effectiveness of the initiatives and support regulators in developing adaptive, flexible monitoring systems for sustainable financing (Alshahmy & Sahiner, 2024).

Despite the increasing recognition of the significance of climate finance in promoting low-carbon development and climate resilience, there still remains a significant knowledge gap on how AI might be utilized inside Tanzania's banking sector to fully utilize these advantages, as the area is under-researched (Saif-Alyousfi & Alshammari, 2025). Current researches focus on traditional barriers such as regulatory limitations, lack of technical capacity, and insufficient integration of climate risk into lending practices. The integration of AI and climate finance has been so overlooked (Alshahmy & Sahiner, 2024; Elias et al., 2024). As financial institutions globally are utilizing data-driven solutions, there is limited empirical evidence on how AI-based decisions support systems may assist Tanzania banks in assessing and evaluating climate risks, optimizing resource allocation, and complying with international climate finance standards. Assessing this gap is essential as it will enable banks to play a transformative role in the nation's response to climate change.

This review is therefore timely and important. It seeks to assess the AI technologies and climate finance mechanisms within the banking sector in Tanzania. The paper aims to provide a comprehensive review of current practices, challenges and opportunities at this integration. The findings will be valuable for researchers, policymakers, and financial professionals, who aim to modernize the climate risk assessment, improve access to sustainable funding, and enhance progress toward national climate objectives. This assessment aims at positioning the Tanzania's banks at the center of sustainable finance by highlighting best practices and strategies to effectively reduce the climate change impacts.

1.1 Research Objective

This literature review is guided by the following objectives;

1. To examine the current state of climate finance mobilization and mitigation strategies in Tanzania's banking sector from 2020-2024, with a focus to Tier 1 and mid-tier banks.
2. To analyze the emerging role of AI in enhancing risk assessment, green product innovation, and ESG compliance in Tanzanian banks
3. To evaluate regulatory developments supporting climate finance in Tanzania and their impact on sustainable banking practices
4. To identify challenges, opportunities, and recommendations for bridging financial gaps and integrating AI for climate-resilient growth

II. THEORETICAL REVIEW

The study is based on two theoretical frameworks to systematically examine the climate finance mobilization and mitigation strategies, AI integration, and sustainable banking practices in Tanzania's banking sector from 2020 to 2024. The Technological Acceptance Model (TAM) and Institutional Theory will help in explaining the drivers of technological, environmental and regulatory adoption response to climate risks, addressing the under-researched interaction of innovation, policy and sustainability.

2.1 Technological Acceptance Model (TAM)

The Technological Acceptance Model (TAM), developed by Davis (1989), provides a theoretical foundation for understanding the AI adoption within the banking sector. The model emphasizes that, the integration of technological innovations, such as AI is primarily driven by two key user perceptions, one being perceived usefulness, example being the application of AI in predictive climate risk model, and second one is perceived ease of use, utilizing digital platforms for ESG scoring. Application of this model to the Tanzania context, the country that is characterized by emerging digital infrastructure (Ally et al., 2025), reveals specific challenges and opportunities. It explains barriers, like technical capacity limitations specially to mid-tier financial institutions, while highlighting AI's potential to enhance resource allocation efficiency. This potential is well demonstrated by CRDB Bank's implementation of satellite based agricultural monitoring systems (CRDB Bank, 2024). TAM highlights the fundamental connection between the attainment of the sustainability objectives and the advancement of technological innovation, thus establishing a crucial dynamic in efforts to bridge the existing climate finance gap.



2.2 Institutional Theory

Institutional Theory, as articulated by DiMaggio and Powell (1983), highlights how organizations conform to external pressures, regulatory mandates, and societal expectations to achieve legitimacy and stability within their institutional environment. In the Tanzanian banking sector, the adoption of climate finance initiatives and sustainable practices has been largely driven by institutional pressure stemming from new regulatory guidelines, such as the country's Guidelines on Climate-Related Financial Risks, which mandate ESG integration and alignment with global norms like the Paris Agreement and Basel III (BOT, 2025; Holscher et al., 2022). These policy frameworks, along with strategies like the National Climate Change Response Strategy (URT, 2021a), create a formal environment that forces banks to align their operations with broader sustainability and climate resilience objectives. Tier 1 banks like CRDB respond to these regulative pressure by issuing green bond, while mid-tier banks are increasingly following path for the successful strategies of these leaders through CSR initiatives and digital compliance to avoid legitimacy deficits (Saif-Alyousfi & Alshammari, 2025). The Institutional Theory then helps to elucidate how external mandates, as well as normative and mimetic forces, shape the strategic responses of banks to climate-related challenges, and highlights opportunities for policy-driven innovation in mitigation strategies (Azeez et al., 2024).

The two theories provide a holistic framework for this literature review. TAM focuses on micro level individual organizational adoption of AI for climate finance efficiency, while Institutional Theory addresses macro level pressure shaping sector-wide sustainability. Their integration reveals how regulatory isomorphism can facilitate AI uptake, supporting Tanzania's low-carbon transition and resilient growth (URT, 2021a). Together, the theories guide the analysis of findings, emphasizing the need for capacity building to overcome adoption barriers and enhance climate resilient banking.

III. METHODOLOGY

3.1 Research Design

This paper employs a qualitative research methodology, based on a comprehensive literature review with the aim to collect and critically evaluate literature on climate finance and sustainable banking in Tanzania from 2020 to 2024, with a focus on the integration of AI, climate change mitigation strategies and the regulatory framework. The review includes scholarly articles and relevant grey literature that discuss how the banking sector responds to climate challenges, AI-driven solutions, and the shifts in regulatory policy. This method allows for a comprehensive understanding of the interaction among sustainability, technological innovations and policy development within the banking sector in Tanzania.

3.2 Data Sources and Search Strategy

Data for this study were drawn from published annual reports of the 44 licensed banks in Tanzania (eg CRDB, NMB, MCB, MKCB, Equity Group). These banks included, 34 commercial banks, 3 microfinance banks, 5 community banks and 2 development finance banks. The data were also drawn from other grey literature, such as government's policy documents including; BoT Guidelines on Climate-Related Financial Risks, 2025; Tanzania's Nationally Determined Contributions (NDCs), National Climate Change Response Strategy (2021-2026), National Five-Year Development Plan 2021/22-2025/26, and National Adaptation Programme of Action (NAPA) to Climate Change (URT, 2023), and other international reports, including World Bank Country Climate and Development Report (CCDR) 2024; and IMF Resilience and Sustainability Facility (RSF) 2024. Data were also drawn from relevant studies from peer-reviewed articles and institutional analysis (REPOA, 2022; World Bank, 2021), which were selected through Scopus, Google Scholar and BoT databases, applying the key words "Tanzania climate finance", "AI sustainable banking" and "mitigation strategies".

Relevant reports from the BoT were also reviewed for an understanding of the regulatory and financial environment that surrounds the banking sector's climate financing implementation and the related mitigation strategies undertaken or planned. The study covered a five-year period from 2020 – 2024, capturing current information which is relevant to the ongoing discussion on climate finance and its financial contribution to that within the Tanzanian's banking sector. Inclusion criteria: Publications specific to Tanzania from 2020 to 2024, relevant to banking, AI and climate. Exclusion criteria: Non-empirical studies, or publications before 2020. This approach with multiple steps, ensures accuracy and minimizes bias that may arise from the banks' self-prepared reports.

3.3 Data Analysis

The data were analyzed using a thematic content analysis method. The method ensures the synthetization of key insights from the reviewed publications; this creates a comprehensive understanding of the climate finance efforts by banks and the mitigations applied within the Tanzanian banking sector. The method involved grouping of similar findings to avoid repetition. Cross-verification was conducted against relevant and reliable metrics from global organizations like International Monetary Fund [IMF] and World Bank for numerical accuracy. This method enabled



the extraction of meaningful insights from relevant grey literature sources, which enables pattern identification in the under-researched areas like AI integration to climate finance specifically in the Tanzanian banking sector.

IV. FINDINGS & DISCUSSION

4.1 Response Rate

This section presents the key findings from the literature review, that was drawn from annual reports of the 44 licensed Tanzanian banks (2020 – 2024), regulatory documents and international reports and scholarly sources. The analysis focuses on the Tanzanian banking sector, emphasizing climate finance mobilization, AI integration, mitigation strategies and regulatory developments. Findings highlight a transitional phase in sustainable banking in Tanzania, the Tier 1 banks such as CRDB and NMB are leading in green finance through green product innovations and digital transformation, while mid-tier institutions like Mwalimu Commercial Bank, Mkombozi Commercial Bank focus on digital foundations, regulatory compliance and CSR. The sector's ability to scale climate finance is hindered by a low private sector credit-GDP ratio (13-16%) (World Bank, 2022) and a projected financial gap of USD 60-70 billion by 2050 for adaptation and mitigation (IMF, 2023).

4.1.1 Climate Finance Landscape in Tanzania (2020-2024)

Tanzania's banking sector has made incremental progress in mobilizing resources for climate finance, by targeting sectors that are most vulnerable to climate change, such as agriculture, renewable energy, and resilient infrastructure. From 2013 to 2018, Tanzania had captured about 20% of East Africa Community climate finance, largely as loans (74%), via multilateral and bilateral channels (REPOA, 2022; World Bank, 2024). By 2020, actual finance mobilization stood at USD 10.7 million (URT, 2021b) against an annual target of USD 304 million, that reflects only 3.6% achievement rate under the FYDP III.

From 2020 to 2024, the climate finance landscape has begun evolving with innovative financial products, developments in the regulatory frameworks and the growing of international support has been evidenced. The Tier 1 banks in Tanzania, such as CRDB and NMB banks, are early adopters of the BOT's (2025) Climate Risk Management Guideline. These banks have concentrated on detailed ESG reporting and green finance innovations. Tier 1 banks have led progress with landmark initiatives, such as the launching of the CRDB Bank PLC "*Kijani*" Green Bond (USD 300 million) in 2023, the issuance is considered the largest in sub-Saharan Africa at its debut and was oversubscribed (by 420%), raising TZS 171.8 billion in its first tranche. The bank has also received senior credit line of USD 25 million and an agriculture adaptation credit of USD 70 million from the Green Climate Fund (GCF), financing programmes for climate adaptation technologies, and climate-related projects (CRDB Bank, 2024).

On the other hand, NMB bank committed TZS 2 billion for Sustainability & Climate Action in 2023, supporting various environmental initiatives. NMB has also raised TZS 400 million (USD 157 million) through *Jamii* Bond, focusing on sustainability and social inclusion (NMB Bank, 2024). Additionally, the IFC anchored USD 25 million in NMB's multicurrency sustainability bonds (issued in late 2023), supporting renewable energy, water, green buildings, clean transport, and affordable housing. These bonds raised a total of USD 159 million and are expected to enable the bank to increase green financing (International Finance Corporation [IFC], 2024).

Furthermore, NBC bank pioneered the Tanga UWASA Green Water Bond, targeting TZS 53.12 billion for climate-resilient water infrastructure (National Bank of Commerce [NBC] Bank, 2024). Absa Bank Tanzania has implemented a Sustainable Finance Framework aligned with its parent group's Net Zero 2050 target, participating in a USD 5 billion pan-African sustainable finance commitment (Absa Bank, 2024). Stanbic bank is active in financing renewable energy infrastructure and sustainable mining, contributing to the Standard Bank Group finance in sustainable finance, with significant allocations to Tanzania projects (Stanbic Bank, 2023). On the other hand, Standard Bank Tanzania is currently transitioning its portfolio to Net Zero and is involved in financing lower-emission transport alternatives like SGR (Standard Gauge Railway). The bank's global USD 300 billion on green finance commitments includes predictive analytics to forecast climate-related defaults risks in Tanzania (Standard Bank, 2024).

In contrast, mid-tier banks, such as Mwalimu Commercial bank and Mkombozi Commercial bank remain focused on CSR initiatives and core digital infrastructure rather than dedicated green finance products. This highlights the need for targeted capacity building and international partnerships to enhance sector-wide climate finance mobilization and support Tanzania's Nationally Determined Contributions (NDCs), which aim to reduce GHG emissions by 30–35% by 2030, yet still fall short of the estimated USD 19.2 billion required (IMF, 2023).

4.1.2 Mitigation Strategies in the Banking Sector

The regulatory landscape outlined by the Bank of Tanzania is consistent with (Azeez et al., 2024) who discussed the importance of a regulatory framework in supporting the banking sector's role in climate change mitigation. Because of their major role in mobilizing finances, the banking sector plays a crucial role by offering green financing products, financing renewable energy initiatives, promoting green loans and providing clients with solutions to reduce carbon



emissions (Lwesya, 2025). This reflects a broader trend of banks supporting both, their own operational sustainability and that of their clients which contributes significantly to the climate change mitigation (Muchiri et al., 2025).

Tanzanian banks increasingly align their mitigation strategies with national policy priorities (NCCRS 2021-2026) by supporting the country's efforts towards a low-carbon transition. In the energy sector, the banking sector has contributed to a shift toward renewables, such as the initiatives in the power supply where hydropower provided 30.6% of electricity in 2021, with natural gas at 64% (Energy and Water Utilities Regulatory Authority [EWURA], 2024). In agriculture, which accounts for 41% of EAC greenhouse gas emissions (Khatibu et al., 2022), banks are now expanding lending for smart practices that takes into consideration the climate issues, irrigations, and resilient crops, as observed in NMB's 10% growth in agriculture loans (NMB, 2023). Urban resilience efforts involve support for public transport, improved waste management, and urban planning that considers climate change impacts.

The literature shows that the CRDB bank's Sustainable Bond Committee has validated Green Bond initiative projects worth TZS 86.9 billion (51%) as eligible for green bond proceeds in 2024. The projects are expected to deliver transformative impacts, from the initiatives that included the installation of 5 MW renewable energy capacity, annual generation of 14GWh of clean energy, and a reduction of 13.87 million tons of CO₂ emissions per year. The bank's innovative financial products under the *Kijani Proposition* have been instrumental in promoting sustainable practices. These include *Angaza Loan* for solar energy financing, *Nishati Safi Loan* supporting LPG and biogas adoption for schools and industries, and the *Recycle Loan* facilitating waste conversion into raw materials for production. Notably the bank sponsored clean cooking campaigns in collaboration with the National Economic Empowerment Council (NEEC), the Ministry of Energy and local media. This programme capacitated the communities by educating them on the negative effects of using charcoal and provided cleaner cooking alternatives like gas cylinders. These efforts contributed directly to reducing deforestation, promoting better health, and enhancing the overall quality of life in the regions the bank serves (CRDB Bank, 2024).

CRDB bank has also secured GCF funding for a senior credit line of USD 25 million to finance green and climate-related projects. Consecutively, the bank has also received a concessional agriculture adaptation credit of USD 70 million from the GCF, which was disbursed in tranches for the Tanzania Agriculture Climate Adaptation Technology Deployment Programme (TACATDP). The programme aims at supporting farmers in accessing loans for climate adaptation technologies, thus enhancing resilience in farming activities and mitigating the effects of climate change on agriculture. Further, in 2023, the bank received a USD 7.9 million grant to support capacity building and policy interventions for promoting adaptation lending and overcoming barriers to addressing climate change impacts (Green Climate Fund [GCF], 2023).

NMB bank, through the Sustainability & Climate Action, has achieved various environmental initiatives, including tree planting (1.2 million trees) and supporting beekeeping groups (500 beehives, 15 groups). In 2024, NMB reported a significant progress, with 203 branches using LED lighting and efforts to convert 8 motor vehicles to CNG. The bank also focused on solar energy adaptation with 1 branch using solar energy in 2023-2024. Further, mitigation measures include increasing the greenness of its loan portfolio by 5% by 2030, expanding its sustainable finance portfolio over the years, achieving a 30% reduction in operational greenhouse gas emissions by 2030. The bank is also making efforts in providing financial solutions to help clients reduce their carbon emissions (NMB Bank, 2024).

Collectively, these strategies are shifting the sector's focus to lending products that are measurable and aligned to climate. However, the majority of the climate finance flows and the ESG reporting remain concentrated with the leading banks. Despite these advancements, only an estimated 5-10% loans are aligned to climate change mitigation initiatives (UNFCCC, 2023), amplifying the need for product innovation and deeper sectoral development including the enhanced use of technology in monitoring and evaluation of the financed projects to ensure ESG compliance.

4.1.3 Role of Artificial Intelligence (AI) in Sustainable Banking

AI has emerged as a force that has overhauled how operations are executed in modern finance, applying applications from algorithmic trading to fraud detection (Maple et al., 2023; Patil & Mailcontractor, 2024). The progressive implementation of AI and machine learning in financial institutions improves decision making, and enhances customer experience and credit scoring (Patil & Mailcontractor, 2024). Furthermore, AI is an important tool which is integrating the traditional finance with sustainability goals, enabling banks to optimize resource allocations, evaluate sustainable investments and develop innovative financial solutions that addresses the ESG challenges (Alshahmy & Sahiner, 2024; Doddipatla, 2023;).

Adoption of AI in the Tanzanian banking sector is at an early stage, primarily supporting climate risk assessment and digital transformation rather than advanced predictive analytics. While AI's capacity to optimize ESG metrics and green finance allocation is well demonstrated globally (Elias et al., 2024), Tanzania's Tier 1 banks are piloting AI-driven credit scoring for agriculture and SME lending, an initiative that improves operational efficiency and risk management (IMF, 2023). NMB and CRDB banks apply big data analytics and AI-driven chatbots for climate analytics, climate shock modelling and loan portfolios, thus broadening the access to green finance (NMB Bank, 2023; CRDB Bank, 2024).



Furthermore, Equity bank's digital transaction rate (86%) is building the data infrastructures which are necessary for future AI-based green finance (Equity Group Holdings, 2024).

The AI and Fintech applications are now aggressively contributing to the new landscape of sustainable banking among the leading banks. CRDB bank applies digital loan platforms to expand climate finance and utilizes satellite-based AI to monitor crop health. This allows the bank to assess the impacts of climate events like floods and droughts on specific farms, which significantly reduces the agricultural credit risk and lowering the risk profile of agricultural loans. The bank also uses its SimBanking and CRDB Wakala (agent banking) digital platforms to deploy financial products that are climate resilient to rural smallholders who were not easily reachable previously, which expands the climate finance outreach (CRDB Bank, 2024).

Absa bank Tanzania has an "Active Force for Good" strategy which mandates the use of technology to filter environmental impact. The bank utilizes credit appraisal system powered by AI that incorporates non-traditional data in credit reviews. During credit reviews for corporate clients, the model assigns an ESG score that factors in a company's carbon footprint and pollution levels. This allows the bank to filter out the clients with high pollution while offering better terms to sustainable businesses (Absa Bank, 2024). Stanbic bank is a major player in the mining sector and is pioneering transparency through Distributed Ledger Technology (DLT) specifically to address the global demand for Critical Transition Minerals like nickel and copper, that are found in Tanzania. The bank integrates Blockchain to create an immutable digital trail, ensuring the minerals were mined ethically, which provides provenance assurance to global buyers (Stanbic Bank Tanzania, 2023).

Standard Chartered bank operates under its strict Net Zero global framework which it has localized for its Tanzania portfolio. The bank has a climate policy that sets out the principles under which it aims to achieve a net zero across their lending and investment portfolio by 2050. The bank uses predictive models to forecast how climate change will affect the collateral value of retail mortgages and the viability of corporate projects. They use AI to evaluate the transition plans of their large corporate clients to ensure they are moving towards lower emissions (Standard Bank, 2024). Through the Tanga Water Supply Authority (Tanga-UWASA) Green Bond, NBC bank uses automated management systems to track the use of the proceeds from the issuance. This ensures that every shilling raised for the water bond is algorithmically verified and directed specifically to the sustainable water infrastructure, preventing greenwashing and ensuring a high level of transparency in the investment (NBC Bank, 2023).

The mid-tier banks are at a digital-first stage, by investing their core banking platforms and expanding agency banking networks. Explicit AI initiatives remain limited, which demonstrates low capacity in the sector and the need to further invest in data infrastructure and technical skills. However, AI is recognized as a tool with high leverage in improving Measurement, Reporting and Verification (MRV) of climate finance, which supports the efforts of the nation in meeting the NDC targets. The Tanzania's banking sector trails global AI maturity due to limited infrastructure, but it was found in this study that, AI could bridge the existing gap by optimizing finance allocations (Ally et al., 2025).

4.1.4 Regulatory Developments and Institutional Context

The regulatory landscape for climate finance and sustainable banking in Tanzania has strengthened between 2020 and 2024. The government introduced the National Climate Change Response Strategy (NCCRS) 2021–2026, updated NDCs, and environmental regulations on carbon trading. In response to the increased recognition of financial risks related to climate change, the BOT issued new Guidelines on Climate- Related Financial Risks Management and Disclosure of 2025, that align with the Basel Committee on Banking Supervision (BCBS) and International Sustainability Standards Board (ISSB) frameworks, which help banks to incorporate climate-related financial risks in their management systems (BOT, 2025; Holscher et al., 2022). The framework mandates ESG integration, Basel II/III compliance in lending, and requiring all banks to disclose and report on the climate risks. This is further enhanced by the Tanzania Bankers Association's Sustainable Finance Principles, which align banking practices with the Paris Agreement and SDGs. The regulator's "Green Bond Framework" (in partnership with the CMSA) supports innovations like the *Kijani*, *Jamiii* and Tanga UWASA bonds in the country. The Fintech Regulatory Sandbox Regulations of 2024 is fostering experimentation with automated ESG scoring and digital green lending (BOT, 2025).

Institutional frameworks, including the National Climate Change Financing Mechanism (NCCFM) and Climate Change Fund (CCF), have centralized monitoring and allocation of climate finance. The Vice President's Office, supported by the National Climate Change Steering Committee and sectoral ministries, coordinates climate policy. International support is exemplified by the IMF's Resilience and Sustainability Facility (IMF, 2023), which aims to build capacity and pilot scaled investments, particularly addressing gaps in mid-tier banks. Complex multi-agency approvals for green bonds, such as NBC's, provide a regulatory blueprint for future climate finance mechanisms. Despite these advances, challenges persist in timely accreditation for GCF access and mobilization of private capital (World Bank, 2022).

4.1.5 Challenges, Opportunities and Implications

This paper identified several barriers that need to be addressed to create a more conducive environment for climate finance in Tanzania. Key challenges limiting the effective utilization of climate finance include delays in



implementing strategies that would facilitate access to climate change funds, insufficient capacity to prepare documentations that meet fund requirements, and lack of accredited institutions capable of accessing funds such as the GFC (Caldwell & Larsen, 2021). Additionally, there are inadequate mechanisms in place to identify and monitor climate change funds mobilized by private sector actors, further hindering the country's ability to fully tap into available financial resources for climate action, evidenced by the severe funding gap (USD 60-70 billion by 2050) (Adom et al., 2024). Uneven AI integration and technical capacity constraints hinder the use of effective predictive analytics that allow financial institutions to optimize resource allocation and assess sustainable investments. On the other hand, the low rate of ESG adoption hinders the ability of the banks to meet fund requirements.

With global efforts to address climate change, opportunities for sustainable economic growth can be seized. These efforts coupled with the growing use of green bonds and sustainability practices, indicate a transformative shift in the banking sector in Tanzania, which will help in mobilizing climate finance and driving the country to a low-carbon economy. Like other East African countries, Tanzania has significantly leveraged FinTech, particularly mobile money platforms, to enhance financial inclusion and revolutionize banking services (Ally et al., 2025). This digital transformation supports the future integration of advanced technologies like AI into sustainable finance practices. Globally, AI usage is emphasized to significantly enhance banking operations for sustainability, including improving efficiency, customer services, and risk management (Saeed & Ashraf, 2024). Therefore, while specific AI applications in climate finance by Tanzania's banks may still be in the early stages of development or remain undocumented, the existing digital infrastructure and the global recognition of AI's role indicate a clear path for its increasing integration in the banking industry (Saeedi & Ashraf, 2024).

The findings in this paper have several implications for the future of climate finance and the banking sector in emerging economies like Tanzania. The findings highlight the increased role of financial institutions, such as CRDB and NMB, in promoting climate finance and mitigation strategies to climate change in Tanzania. These banks do not only integrate sustainability into their operations, but also play an active role by mobilizing capital for climate change mitigation initiatives. This demonstrates the growing recognition that the banking sector can be a key player in financing the transition to a low-carbon economy, a role that can be amplified by the transformative power of Artificial Intelligence in enhancing risk assessment, optimizing green credit allocations, and enabling more effective monitoring of climate finance initiatives. The implementation of green bonds, such as CRDB's issuance of Tanzania's first green bond, illustrates the importance of innovative financial instruments that support sustainable projects. Furthermore, the oversubscription of the bonds (by 420%) represents a pioneering step in Tanzania's sustainable landscape. This trend aligns with the global practices and positions Tanzania as a leader in green finance in the East and Central African Region (World Bank, 2022).

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This paper concludes that, the Tanzanian banking sector, particularly through CRDB and NMB bank, plays a significant role in advancing climate financing and supporting mitigation strategies in Tanzania in the five-year period of 2020 – 2024. These include supporting climate-resilient projects, issuance of green bonds, the integration of environmental sustainability into their operations, developments in regulatory frameworks, and the increasingly use of support from emerging technologies like AI in risk management and monitoring of climate finance initiatives. The proactive measures taken by the banks in Tanzania, supported by regulatory guidelines from the Bank of Tanzania, demonstrate an important contribution to building a sustainable and climate-resilient economy. Tier 1 banks, such as CRDB and NMB, have demonstrated leadership in green product development, digital transformation and improved compliance. Despite these achievements, the sector is still hindered by uneven technological advancements, a substantial financing gap, and capacity challenges particularly in AI and advanced analytics. Tanzania's effective realization of climate ambitions will require sustained regulatory reform, targeted capacity building, and strategic use of technology to foster innovation, transparency and inclusion in climate finance.

5.2 Recommendations

The paper recommends that Tanzanian banks should expand their involvement in climate change financing by increasing their investment in climate-resilient projects. A crucial step in this process is investing in capacity building within the financial sector. By equipping financial institutions, policymakers and other stakeholders with the knowledge and tools necessary to understand and manage climate-related risks and opportunities, Tanzania will be better prepared to drive the transition to a low-carbon economy. A more knowledgeable and capable banking sector which is more informed and capable will enable the country to effectively access and allocate climate finance, support mitigation and adaptation strategies, and foster sustainable development. Additionally, Tanzanian commercial banks and financial institutions should strengthen their partnerships with international climate finance mechanisms, such as the Green



Climate Fund (GCF), Global Environment Facility (GEF), and Climate Investment Funds (CIF). These collaborations can provide access to concessional funding, further supporting sustainable development initiatives.

To further enhance the banking industry's role in climate action, it is essential to improve regulatory frameworks that promote green financial products and integrate climate risk management into banking operations. There is also a need to accelerate regulatory innovations through initiatives like, green taxonomies implementation, climate risk stress testing, and relevant systems to support greater transparency and accountability in climate finance. This will strengthen the financial sector's ability to contribute to long-term sustainability goals.

Declaration of Interest

The author declares that she does not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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