A Digital Transformation Maturity Model for Driving Innovation in African Banking and Payments Infrastructure

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Abstract- ***The rapid evolution of digital technologies presents a transformative opportunity for African banking and payments ecosystems, which continue to grapple with infrastructure gaps, legacy systems, and fragmented regulatory environments. Despite the proliferation of mobile money, fintech innovation, and expanding digital financial services, many institutions across the continent remain at varying and often early stages of digital maturity. To address this disparity and provide a structured path toward innovation and resilience, this proposes a Digital Transformation Maturity Model for Africa's Banking and Payments Infrastructure (DTMM-Africa). The model conceptualizes digital transformation as a progressive, multidimensional process comprising five key stages: Initiation, Digitization, Integration, Optimization, and Innovation. It is built on five core dimensions critical to banking modernization: Technology and Infrastructure, Data and Analytics, Governance and Compliance, Customer Experience, and Ecosystem Partnerships. Each maturity stage is defined by specific indicators that institutions can use to assess their readiness, set strategic goals, and benchmark progress. This framework is informed by existing digital maturity theories, contextualized for the African landscape through regional case studies (e.g., Nigeria's real-time payment systems, Kenya's mobile money-bank convergence, Ghana's interoperability platforms), and supported by policy insights. The model emphasizes not only technological capacity but also regulatory agility, institutional collaboration, and customer-centric design as prerequisites for meaningful digital transformation. The DTMM-Africa provides a practical roadmap for banks, fintechs, regulators, and development partners to align investments, coordinate reforms, and accelerate innovation. It is intended to support inclusive financial development, foster regional integration, and position African financial ecosystems to compete in a globally digitized economy. Future research should explore automated maturity assessments, cross-border digital compliance mechanisms, and inclusive UX standards tailored to African markets.***

Index Terms- ***Digital, Transformation, Maturity model, Driving innovation, African banking, Payments infrastructure***

I. INTRODUCTION

In the era of digital globalization, banking and financial services are undergoing rapid and transformative change (Akinbola, O.A. and Otoki, 2012; Lawal *et al*., 2014). Around the world, traditional financial institutions are leveraging cloud computing, artificial intelligence (AI), blockchain, and data analytics to improve efficiency, personalize customer experiences, and deliver more inclusive services (Lawal *et al*., 2014; Otokiti and Akorede, 2018). The digital transformation of banking is not merely a technological shift but a strategic realignment of institutional processes, business models, and customer engagement (Ajonbadi*et al*.,

2015; Otokiti, 2017). In advanced economies, this transformation has matured into platform-based ecosystems that integrate payments, credit, wealth management, and even insurance in seamless, customer-centric digital journeys (SHARMA *et al*., 2019; Otokiti, 2012).

In contrast, Africa's banking and payments sectors are simultaneously facing immense challenges and unprecedented opportunities (Ajonbadi *et al*., 2016). On one hand, fintechs and mobile money operators have emerged as catalysts for financial inclusion. Services like M-Pesa in Kenya, Paga in Nigeria, and MTN MoMo across West Africa have enabled millions of previously unbanked individuals to access digital financial services (Otokiti, 2018; Adenuga *et al*., 2019). Africa is currently home to more than half of the world's mobile money accounts, demonstrating a unique leapfrogging of conventional banking structures. On the other hand, infrastructure gaps, regulatory fragmentation, and institutional inertia continue to hinder the continent's ability to scale these innovations systemically (Otokiti and Akinbola, 2013; Ajonbadi *et al*., 2014).

Many banks in Africa still rely on legacy core banking systems, operate in regulatory environments that lag behind technological advances, and face high costs in modernizing their platforms (Zalan and Toufaily, 2017; Wilson, 2017). Payment infrastructures are often non-interoperable across institutions and borders, impeding the realization of continent-wide financial integration, despite initiatives such as the African Continental Free Trade Area (AfCFTA) and the Pan-African Payment and Settlement System (PAPSS). These innovation bottlenecks limit the scalability and efficiency of digital finance, despite the continent's burgeoning youth population, growing smartphone penetration, and expanding internet access.

The central problem, therefore, is that fragmented digital systems, uneven institutional capacity, and regulatory lag are inhibiting Africa's banking sector from fully leveraging the benefits of digital transformation (Ng'ambi *et al*., 2016; Abrahams, 2017). This fragmentation not only slows innovation but also undermines customer trust, increases operational costs, and perpetuates financial exclusion. While individual fintechs and mobile platforms may demonstrate strong innovation potential, their integration into formal financial systems and cross-border frameworks remains limited and uneven. Without a unified approach to digital transformation, many African institutions risk falling further behind global counterparts in terms of both competitiveness and resilience (George *et al*., 2016; Ndemo and Weiss, 2017).

To address this, the objective of this review is to propose a Digital Transformation Maturity Model for African Banking and Payments Infrastructure (DTMM-Africa). This model aims to provide a structured, progressive framework that financial institutions, regulators, and ecosystem stakeholders can use to assess their current capabilities, identify gaps, and chart a roadmap toward more integrated, innovative, and resilient digital infrastructures. Unlike generic maturity models developed for high-income markets, DTMM-Africa is contextually adapted to reflect Africa's regulatory diversity, infrastructural constraints, and financial inclusion imperatives.

The DTMM-Africa is built upon five progressive stages—Initiation, Digitization, Integration, Optimization, and Innovation—each defined by specific criteria across five core dimensions: Technology and Infrastructure, Data and Analytics, Governance and Compliance, Customer Experience, and Ecosystem Partnerships. These dimensions are essential for the modernization of banking institutions and the development of agile, inclusive payment systems.

The methodology used to construct the DTMM-Africa model is rooted in a conceptual framework informed by extensive literature review on digital transformation, maturity models, and financial innovation theories. It integrates case studies of successful African initiatives—such as Nigeria's NIBSS instant payments platform, Ghana's interoperability framework, and Kenya's mobile banking convergence—with insights from policy reports, regulatory white papers, and strategic roadmaps from pan-African and global financial development institutions. The model is also influenced by global maturity frameworks such as the

Capability Maturity Model Integration (CMMI), while adjusting for the unique challenges of the African context, including informal economies, limited credit penetration, and mobile-first user behavior (Langston and Ghanbaripour, 2016; Arends and Advisory, 2018).

This presents DTMM-Africa as a practical and context-aware tool to support digital transformation planning, benchmarking, and policy alignment. By enabling institutions to understand their maturity stage and prioritize areas for investment and reform, the model seeks to accelerate the development of a more integrated, innovative, and inclusive financial ecosystem across the African continent.

II. METHODOLOGY

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology was used to guide the systematic literature review informing the development of the Digital Transformation Maturity Model for Driving Innovation in African Banking and Payments Infrastructure. The review process followed a structured and replicable approach to identify, screen, and select relevant academic and grey literature, ensuring the model is grounded in empirical evidence and best practices.

The data sources included Scopus, Web of Science, IEEE Xplore, ScienceDirect, and Google Scholar, as well as policy documents from international financial institutions such as the World Bank, African Development Bank (AfDB), the International Monetary Fund (IMF), the Alliance for Financial Inclusion (AFI), and regional regulators such as the Central Bank of Nigeria and the Bank of Ghana. The search strategy applied Boolean operators and keywords such as “digital transformation,” “banking maturity model,” “financial innovation,” “Africa fintech,” “payments infrastructure,” and “financial inclusion.” Literature published between 2010 and 2024 was considered, reflecting the period of rapid fintech expansion and digital finance adoption across the continent.

The initial search yielded 362 documents. After removal of duplicates and non-English publications, 275 records were screened based on title and abstract relevance. Of these, 126 full-text documents were assessed for eligibility using inclusion criteria: (i) relevance to banking or payments systems, (ii) focus on digital transformation or technology adoption, and (iii) applicability to African or developing country contexts. Studies focusing exclusively on high-income economies, non-financial sectors, or speculative technologies without operational case studies were excluded. A total of 62 sources met the criteria and were included in the final synthesis.

The extracted data were thematically analyzed and categorized under five thematic dimensions: technology and infrastructure, data and analytics, governance and compliance, customer experience, and ecosystem collaboration. These informed the design of the DTMM-Africa framework, supported by illustrative African case applications. The transparent use of PRISMA ensures replicability, reduces bias, and strengthens the model’s analytical and policy relevance.

2.1 Theoretical Foundations

The development of a Digital Transformation Maturity Model tailored to African banking and payments infrastructure draws upon multiple theoretical foundations spanning digital maturity assessment, innovation diffusion, technology adoption, and financial development economics. These theories offer structured insights into how organizations evolve, how technology permeates societies, and how financial systems catalyze inclusive growth (Zhao and Wry, 2016; Spigel, 2017). This provides an integrative overview of three key conceptual domains: digital maturity models, innovation and technology adoption theories, and financial inclusion frameworks within development economics.

Digital maturity models (DMMs) provide structured frameworks to assess and guide the evolution of digital capabilities within organizations. These models typically define sequential stages through which institutions progress as they adopt and institutionalize digital technologies, moving from ad hoc or experimental deployments to fully optimized, data-driven ecosystems.

One of the earliest and most widely adopted frameworks is the Capability Maturity Model (CMM), developed by the Software Engineering Institute. Originally designed for software development processes, CMM defines five levels of maturity: Initial, Repeatable, Defined, Managed, and Optimizing. Although domain-specific, this model laid the foundation for assessing organizational learning, standardization, and process improvement—principles that extend naturally to digital transformation initiatives.

Building upon CMM, various digital-specific maturity models have emerged to reflect the complexity of modern information systems and business ecosystems. For instance, Deloitte's Digital Transformation Maturity Model (DTMM) encompasses six dimensions: customer, strategy, technology, operations, organization and culture, and data. Each dimension is assessed across five maturity levels, from "initial" to "leading," enabling firms to benchmark their digital readiness and develop targeted strategies.

In the financial services domain, digital maturity models help institutions evaluate capabilities such as real-time data analytics, cloud adoption, digital product development, and omnichannel service delivery (Mittal *et al*., 2018'; Hamidi *et al*., 2018). However, these models are largely tailored to high-income contexts with advanced infrastructure and high digital literacy. For African institutions operating within infrastructural, regulatory, and socio-economic constraints, a contextual adaptation is necessary. The DTMM-Africa model thus builds upon the core principles of global DMMs but modifies indicators and progression logic to reflect the unique features of the African banking and payments ecosystem.

Understanding how financial institutions and users adopt new digital tools also requires a theoretical grounding in innovation diffusion and technology acceptance models. The Diffusion of Innovations (DOI) theory, formulated by Everett Rogers, explains how innovations spread through a population over time. According to this theory, adoption is influenced by factors such as relative advantage, compatibility, complexity, trialability, and observability. The model identifies five categories of adopters—innovators, early adopters, early majority, late majority, and laggards—each with different attitudes toward risk and change.

In the African banking context, DOI helps explain the variable uptake of technologies like mobile money, biometric authentication, and open banking APIs across regions and demographic groups. For example, early adoption of mobile money services in Kenya contrasts with slower uptake in countries with less telecommunications infrastructure or regulatory support.

Complementing DOI, the Technology Acceptance Model (TAM) developed by Davis emphasizes two primary drivers of technology adoption: perceived usefulness and perceived ease of use. Variants of TAM such as the Unified Theory of Acceptance and Use of Technology (UTAUT) incorporate additional factors like social influence, facilitating conditions, and user trust. In financial services, these models are crucial for understanding customer adoption of mobile banking apps, digital wallets, and online credit systems—especially in underserved or skeptical user segments (Zhang *et al*., 2018; Omarini, 2018).

From an institutional perspective, technology adoption is also shaped by organizational readiness, IT competence, and leadership commitment, as described in frameworks like the Technology-Organization-Environment (TOE) model. African banks and fintechs, often constrained by legacy systems, skills gaps, and regulatory uncertainty, must navigate these factors to move from pilot innovation to operational scale. The DTMM-Africa model therefore incorporates stages of adoption that recognize not just technological availability, but the internal and external environments that enable or inhibit transformation.

The third foundational pillar of the DTMM-Africa model lies in development economics, particularly the literature on financial inclusion as a driver of economic development. Financial inclusion refers to the access and effective use of formal financial services by individuals and businesses, particularly

those traditionally excluded due to poverty, geography, or informality.

Numerous studies have shown that inclusive financial systems enhance economic growth, reduce inequality, and support poverty alleviation. Access to savings, credit, insurance, and payment mechanisms enables households to smooth consumption, invest in education and health, and respond to economic shocks. For small and medium enterprises (SMEs), financial access facilitates capital formation and operational stability. In sub-Saharan Africa, where a large proportion of the population remains unbanked, digital financial services have emerged as critical enablers of inclusion (Osano and Languitone, 2016; Igwe *et al*., 2018).

Infrastructure—both digital and financial—is central to this transformation. The World Bank's Digital Economy for Africa (DE4A) initiative highlights the importance of interoperable payment systems, digital ID frameworks, and affordable internet access in driving inclusive finance. Likewise, the Alliance for Financial Inclusion (AFI) emphasizes regulatory innovation, consumer protection, and gender-inclusive policies as essential elements of digital financial inclusion.

The DTMM-Africa model is designed not just to assess technological sophistication, but also to capture progress toward inclusive innovation. This includes the ability of institutions to serve marginalized groups, build trust among low-literacy users, and support regulatory frameworks that protect consumers while fostering innovation. It acknowledges that digital maturity in the African context must be evaluated not only by the sophistication of technologies adopted, but also by their social utility and accessibility.

2.2 African Banking and Payments Landscape

The African banking and payments landscape is undergoing a dynamic transformation, marked by rapid technological innovation, shifting customer expectations, and evolving regulatory responses. While the continent lags behind advanced economies in traditional financial infrastructure, it has emerged as a global leader in certain domains of digital finance, particularly mobile money. The interplay between legacy institutions, new entrants, and policy actors is reshaping how financial services are delivered, accessed, and regulated (Chiu, 2016; Fasnacht, 2018). However, progress remains uneven, and significant structural and systemic challenges continue to constrain the full realization of an inclusive, integrated, and innovation-driven financial ecosystem.

The African financial services ecosystem comprises four primary categories of actors: commercial banks, fintech startups, mobile network operators (MNOs), and regulatory institutions. Traditional banks, long the custodians of formal financial intermediation, are increasingly facing competition from agile fintech firms and MNOs that offer more accessible, lower-cost alternatives. Many banks still operate legacy core banking systems with limited digital touchpoints and geographic reach, particularly in rural and peri-urban areas (Foth, 2017; Chuen and Deng, 2017).

Fintechs have emerged as key disruptors, leveraging mobile-first strategies and cloud-native platforms to deliver innovative solutions in payments, savings, lending, and wealth management. These startups often fill gaps left by traditional banks, particularly in serving small businesses, informal sector participants, and youth populations. Kenya's M-Pesa, Nigeria's Flutterwave, and South Africa's Yoco are prominent examples of African fintechs transforming digital payments, merchant services, and cross-border remittances.

Mobile Network Operators (MNOs) play a particularly critical role in Africa's financial ecosystem due to their ubiquitous reach and robust mobile infrastructure. By leveraging SIM-based wallets and USSD interfaces, MNOs have enabled millions of unbanked individuals to transact digitally without needing a bank account. MTN MoMo, Orange Money, and Airtel Money collectively serve over 400 million users across Africa.

Regulators and central banks are evolving to accommodate these trends, often balancing innovation promotion with consumer protection and systemic stability. Entities such as the Central Bank of Kenya, Central Bank of Nigeria, and Bank of

Ghana have introduced regulatory sandboxes, payment system oversight frameworks, and digital ID integration policies to foster innovation within controlled parameters. However, differences in regulatory capacity, enforcement, and openness to innovation continue to characterize the regional landscape (Cooke, 2016; Bromberg *et al*., 2017).

Africa is home to some of the most advanced mobile money markets in the world. Mobile money usage continues to rise, with over 760 million registered accounts and transaction volumes exceeding $800 billion in 2022, according to GSMA. Countries like Kenya, Ghana, and Côte d'Ivoire report mobile money penetration rates above 70%, while others, including Nigeria and Ethiopia, are beginning to liberalize the sector to enable similar growth.

The rise of instant payments and real-time settlement systems is another notable trend. Nigeria's NIBSS Instant Payments (NIP), launched in 2011, has facilitated rapid, low-cost fund transfers and spurred fintech innovation. Ghana's GhIPSS and Tanzania's TIPS also illustrate regional efforts to achieve real-time interoperability across banks and MNOs. These platforms enhance liquidity, reduce transaction costs, and support the digitization of small-value payments—critical for financial inclusion.

Digital identity systems are increasingly recognized as foundational enablers of financial access (Atick, 2016; Domingo and Enríquez, 2018). Countries such as Nigeria (via the National Identity Number, NIN) and Ghana (via the Ghana Card) have integrated biometric digital IDs into banking and mobile money onboarding processes. This has streamlined know-your-customer (KYC) compliance and enabled scalable, secure customer verification. As more governments roll out national ID programs, interoperability and cross-sector integration will be key to unlocking their full potential (Eimicke, 2018; Charalabidis *et al*., 2018).

Beyond national initiatives, regional and continental integration efforts such as the Pan-African Payment and Settlement System (PAPSS), launched under the AfCFTA, seek to harmonize cross-border payments and reduce reliance on foreign currencies. Such platforms have the potential to enhance intra-African trade, support SME internationalization, and reduce remittance costs, which remain among the highest globally.

Despite these advances, Africa's banking and payments infrastructure faces substantial challenges. The most pressing among them is the infrastructure gap. Reliable electricity, internet connectivity, and data centers remain scarce or inconsistent in many rural and peri-urban areas. This hampers the scalability of cloud-based services, real-time transactions, and digital identity verification. Many banks and fintechs are compelled to maintain costly hybrid infrastructures to operate across diverse environments with variable connectivity (Hendrikse *et al*., 2018; Carmona *et al*., 2018).

Regulatory fragmentation is another significant constraint. Financial regulations vary widely across African jurisdictions, with differing requirements for licensing, KYC, capital adequacy, and digital innovation. This inconsistency creates high compliance costs, deters cross-border expansion, and limits the scalability of digital services. While some regional economic communities, such as the West African Monetary Zone (WAMZ) and the Southern African Development Community (SADC), have begun to promote regulatory harmonization, progress is slow and uneven.

Cybersecurity risks are rising alongside digital adoption. As more consumers and institutions move financial activities online, the continent has seen a surge in cyber threats, including phishing, mobile fraud, and system breaches (Bhasin, 2016; Dandapani, 2017). Many institutions lack the capacity, tools, and trained personnel to effectively mitigate these risks. Moreover, fragmented data protection laws and limited enforcement mechanisms further expose users to privacy violations and financial harm.

The dominance of informal economies across much of Africa presents additional complexity. Informal traders, gig workers, and subsistence farmers constitute a large share of economic activity but often lack formal identification, stable income, or access to digital tools. Designing financial services that accommodate variable income streams, oral

transactions, and trust-based social networks remains a design and delivery challenge. Innovations such as agent banking, voice-based user interfaces, and group savings platforms are beginning to address these gaps, but greater investment in contextual service design is needed (Revang *et al*., 2018; Tuzovic and Paluch, 2018; Best, 2018).

Finally, digital literacy and consumer trust continue to shape adoption trajectories. Mistrust in digital platforms, concerns over fraud, and limited awareness of digital financial services prevent many users from transitioning away from cash-based systems. Building trust will require transparent governance, user education, and grievance redress mechanisms that are both accessible and effectively (Creutzfeldt, 2016; Stevens *et al*., 2018).

2.3 The Digital Transformation Maturity Model (DTMM-Africa)

In response to the fragmented development of digital capabilities across Africa's banking and payments landscape, the Digital Transformation Maturity Model for Africa (DTMM-Africa) provides a structured framework to guide financial institutions, regulators, and technology partners through a phased journey of digital maturity. The model acknowledges the diversity of contexts across the continent—ranging from countries with advanced mobile money ecosystems to others where banking penetration remains low—and offers a scalable pathway for aligning innovation with institutional readiness, policy support, and user needs as shown in figure 1.

The DTMM-Africa adopts a five-stage progression model that reflects the sequential development of digital capabilities and strategic integration within financial institutions and their broader ecosystems. These stages are; Initiation, characterized by ad hoc and experimental use of digital tools. Institutions in this stage lack a formal digital strategy, with limited internal capabilities and minimal automation of processes. Digitization, digital technologies are deployed to replicate existing processes, such as automating back-office operations or launching basic mobile interfaces (Lamberton *et al*., 2017; Turban *et al*., 2018). There is an increased focus on operational efficiency and cost reduction. Integration, digital systems are increasingly interoperable and connected across departments. Customer touchpoints become unified, and data is shared across functions to support informed decision-making.

Figure 1: Core Dimensions

Optimization, digital tools are strategically aligned with business goals. Advanced analytics, real-time monitoring, and AI-driven decision support systems are used to personalize services and improve risk management. Innovation, institutions act as digital leaders, engaging in continuous innovation, co-creation with stakeholders, and cross-border ecosystem development. There is full alignment between digital capabilities, organizational culture, and customer-centric strategies.

This progression is not strictly linear; institutions may advance or regress depending on external shocks, internal restructuring, or regulatory changes. However, the framework offers a normative guide for transformation by establishing benchmarks and setting strategic priorities at each stage.

To operationalize the model, DTMM-Africa is structured around five core dimensions that represent the foundational pillars of digital transformation in the African banking and payments context; Technology and Infrastructure, this dimension assesses the extent to which institutions have deployed foundational and emerging digital technologies, including cloud computing, APIs, mobile platforms, cybersecurity tools, and core system modernization (Battleson *et al*., 2016; Benlian *et al*., 2018). It also considers physical and network infrastructure dependencies, such as data centers, bandwidth, and power reliability.

Data and Analytics, this component evaluates capabilities related to data collection, governance, storage, and analysis. It includes the adoption of business intelligence tools, machine learning models, and data-driven decision-making processes. Data quality, security, and regulatory compliance are integral considerations.

Governance and Compliance, focused on institutional alignment with national and regional regulatory frameworks, this dimension considers digital risk management, data protection policies, ethical AI standards, and adherence to anti-money laundering (AML) and know-your-customer (KYC) protocols. It also includes participation in regulatory sandboxes and supervisory technology (SupTech) systems.

Customer Experience, this pillar emphasizes the use of digital channels to improve user engagement, service delivery, and personalization. Metrics include digital onboarding rates, user interface accessibility, mobile responsiveness, and grievance redressal mechanisms. Cultural sensitivity and trust-building are especially crucial in low-literacy and rural contexts.

Ecosystem Partnerships. recognizing the importance of collaborative innovation, this dimension assesses participation in digital ecosystems, including partnerships with fintechs, MNOs, government agencies, and international development partners (Davis, 2016; Fasnacht, 2018; Fenwick *et al*., 2018). It measures interoperability, co-creation platforms, and integration with national ID and payment systems.

These dimensions are interdependent; for example, data analytics is only as effective as the underlying technology infrastructure and regulatory permissions governing data use. As such, maturity in one area often enables or constrains progress in others.

To support practical implementation, each stage of the DTMM-Africa model is defined by qualitative and quantitative indicators across the five dimensions. Examples include; Technology and Infrastructure; *Initiation*, reliance on paper-based processes; fragmented systems; minimal IT investment. *Integration*, use of open APIs for third-party integration; mobile-first platforms. *Innovation*, AI-driven service orchestration; blockchain-enabled settlements.

Data and Analytics; *Digitization*, introduction of spreadsheets and basic dashboards. *Optimization*, use of predictive analytics for credit scoring, fraud detection. *Innovation*, real-time behavioral analytics and AI personalization engines.

Governance and Compliance; *Initiation*, limited digital oversight; manual compliance reporting. *Integration*, automated KYC/AML tools; participation in sandbox frameworks. *Innovation*, embedded compliance engines; active policy co-creation with regulators.

Customer Experience; *Digitization*, basic mobile app; unidirectional communication. *Optimization*, omnichannel access; dynamic feedback loops via chatbots. *Innovation*, hyper-personalized journeys; voice- and vernacular-enabled interfaces.

Ecosystem Partnerships; *Initiation*, minimal collaboration; siloed operations. *Integration*, joint ventures with fintechs; interoperable mobile money linkages. *Innovation*, open banking APIs; multi-country digital corridors.

These indicators enable institutions to self-assess their current position, identify gaps, and set goals for progression. Governments and development agencies can also use the model for benchmarking national digital finance readiness and prioritizing capacity-building initiatives (Hohmann *et al*., 2017; Hameed *et al*., 2018).

2.4 Implementation Strategy

Successfully operationalizing the Digital Transformation Maturity Model for Africa (DTMM-Africa) requires a strategic, phased approach that combines institutional self-assessment, roadmap development, and multi-stakeholder collaboration as shown in figure 2. While the model offers a conceptual framework for measuring digital maturity across banking and payment systems, its value lies in its practical application to real-world institutions across varying contexts (Flott *et al*., 2016; Megargel

et al., 2018). This implementation strategy outlines key components that enable the model to drive structured transformation: self-assessment and benchmarking tools, strategic planning for maturity progression, and the pivotal role of regulators and development partners.

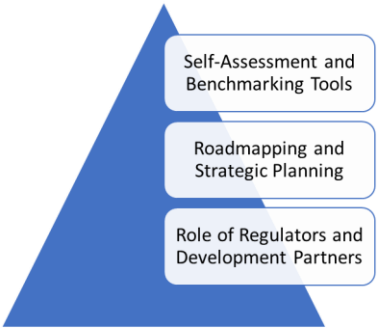

Figure 2: Implementation Strategy

The foundation of DTMM-Africa's implementation lies in the ability of institutions to assess their current digital maturity. Self-assessment tools, grounded in the five-stage and five-dimension architecture of the model, enable banks, fintechs, and payment service providers to identify their position along the transformation spectrum. These tools should be modular, scalable, and adaptable to various organizational sizes and market environments.

A comprehensive maturity diagnostic toolkit should include; Surveys and checklists to assess capabilities in technology infrastructure, data analytics, governance, customer experience, and ecosystem partnerships. Weighted scoring systems to evaluate qualitative inputs (e.g., culture of innovation, stakeholder engagement) and quantitative metrics (e.g., API uptime, digital adoption rates). Dashboards to visualize maturity levels, enabling institutions to benchmark internally across departments or externally against peer institutions.

Standardization of assessment tools also enables industry-level benchmarking. For example, national banking associations or central banks could use aggregated data to map sector-wide readiness, identify innovation clusters, and prioritize support for lagging institutions. Benchmarking enables transparency, accountability, and the creation of incentives for progress, such as regulatory fast-tracks or innovation funding tied to maturity advancement (Li *et al*., 2018; Kuriyama *et al*., 2018).

Once institutions have assessed their maturity, the next step involves strategic planning and roadmapping to guide progression from one stage to the next. A transformation roadmap is more than a technology implementation plan; it is a holistic change management framework that aligns people, processes, and technology.

Key components of an effective roadmap include; Gap analysis between current and target maturity stages. Prioritized interventions, such as upgrading infrastructure, building data pipelines, or redesigning digital customer journeys. Timelines and milestones, structured in short (0–1 year), medium (1–3 years), and long-term (3–5 years) phases. Resource allocation plans, including funding sources, human capital requirements, and external technical support.

A robust roadmap should integrate agile principles, allowing institutions to iterate based on real-time feedback and emerging opportunities. For example, a bank in the digitization phase might initially focus on mobile banking upgrades but pivot to API development if interoperability becomes a strategic priority due to market shifts.

Strategic planning must also address organizational culture and governance. Leadership commitment is essential to sustain transformation. Cross-functional governance teams involving IT, operations, compliance, and customer experience units help ensure alignment and accountability. Institutions should also invest in capacity building, including staff upskilling, change management workshops, and partnerships with innovation labs or academic institutions (Becker *et al*., 2016; Kolding *et al*., 2018).

The enabling environment—comprised of regulatory institutions, development agencies, and industry associations—plays a central role in facilitating the adoption and scaling of DTMM-Africa. These actors provide policy support, funding mechanisms, and platforms for knowledge exchange that are crucial for overcoming systemic barriers.

Regulators, particularly central banks and financial authorities, have a dual role: enforcing compliance and fostering innovation. To support digital maturity progression, regulators can; Develop national digital finance strategies that align with the DTMM-Africa framework. Implement tiered licensing regimes that reflect institutional maturity levels and risk exposure, such as limited licenses for sandbox participants and full licenses for advanced digital banks. Promote interoperability standards, digital ID integration, and open banking frameworks that facilitate ecosystem collaboration. Build Supervisory Technology (SupTech) capabilities to monitor digital financial institutions more effectively.

Furthermore, regulators can establish regulatory sandboxes and innovation offices to support pilot testing and iterative policy development (Zetzsche *et al*., 2017; Brummer and Yadav, 2018). These platforms help institutions at lower maturity stages experiment safely while building regulatory capacity to handle emerging technologies.

Development partners—including multilateral institutions (e.g., World Bank, African Development Bank), donor agencies, and foundations—can amplify impact through; Funding infrastructure investments, especially for institutions operating in low-income or rural contexts. Technical assistance and capacity building, such as digital skills training, cybersecurity readiness programs, and governance frameworks for ethical AI. Research and knowledge dissemination, including case studies, toolkits, and regional benchmarking reports to inform policy and practice.

Public-private partnerships (PPPs) are especially effective for pooling resources, sharing risks, and accelerating the deployment of transformative technologies. For example, a PPP might fund the rollout of interoperable payment infrastructure across multiple banks and fintechs, while ensuring compliance with regulatory data-sharing protocols.
Development partners also have a key role in mainstreaming inclusion, ensuring that digital transformation agendas address gender equity, youth engagement, rural outreach, and the needs of persons with disabilities. Their involvement can shift digital maturity from a narrow technological focus to a broader social impact framework.

2.5 Challenges and Limitations

While the Digital Transformation Maturity Model for Africa (DTMM-Africa) provides a structured framework to guide banking and payment institutions through progressive stages of digital development, its practical implementation is fraught with challenges and limitations. These challenges span technical, organizational, regulatory, and socio-economic domains, often reinforcing one another in complex ways as shown in figure 3(O'Neill *et al*., 2017; Staddon et aal., 2018). This discusses four critical constraints that limit the adoption and impact of DTMM-Africa: legacy systems and fragmentation, resource and capacity constraints, data governance and interoperability, and resistance to change and institutional inertia.

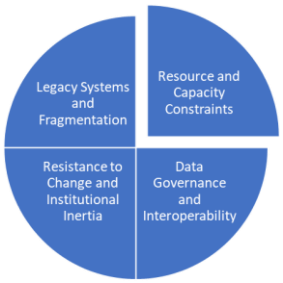

Figure 3: Challenges and Limitations

One of the foremost challenges facing financial institutions in Africa is the presence of legacy systems—outdated core banking and payment infrastructures that are often poorly integrated, difficult to upgrade, and incompatible with modern digital technologies. These systems were typically built for manual, centralized operations, with limited ability to support APIs, mobile interfaces, cloud computing, or real-time data exchange. This creates substantial barriers to the digitization and integration phases of the maturity model.

In many African countries, systemic fragmentation across banking institutions, fintech providers, and mobile money operators further exacerbates the challenge. These entities often use incompatible software stacks and standards, leading to siloed data, redundant operations, and inefficient service delivery.

Fragmentation also manifests at the national level, where payment platforms and digital identity systems vary widely in design, coverage, and regulatory oversight. Without a coordinated architecture or national interoperability frameworks, institutions may face high integration costs and diminished incentives to innovate (Panetto *et al*., 2016; Teece, 2017).

Moreover, legacy systems are often accompanied by long-term vendor lock-ins and rigid procurement contracts, making upgrades financially and logistically burdensome. Institutions in the lower stages of maturity often lack the bargaining power or internal expertise to negotiate transitions to more flexible, modular digital systems. As such, transforming legacy infrastructure is not merely a technical undertaking but also a strategic and financial challenge.

Implementing DTMM-Africa requires substantial financial and human capital, both of which are in short supply across many African financial institutions. Small and mid-sized banks, microfinance institutions, and rural savings cooperatives frequently operate on tight margins and face liquidity constraints, making it difficult to invest in advanced digital infrastructure, cybersecurity systems, or data analytics capabilities.

Human resource limitations are equally critical. There is a widespread shortage of digitally skilled professionals—including software engineers, data scientists, UX designers, and cybersecurity experts—across the continent. Many institutions rely on external consultants for short-term solutions, resulting in fragmented knowledge transfer and weak internal capacity. Additionally, institutions may lack specialized departments, such as digital transformation units or innovation labs, which are essential for sustained organizational change.

These constraints are especially acute in fragile or post-conflict states, where political instability, underdeveloped education systems, and limited private-sector activity hamper institutional capacity-building. Even where donor funding or technical assistance is available, absorption capacity is limited, and project sustainability often becomes a concern once external support ends (Anadon *et al*., 2016; Kim, 2018).

Without adequate resources and skilled personnel, institutions struggle to progress beyond the digitization stage of the maturity model. This creates a digital divide between better-resourced urban banks and fintechs, and underfunded institutions serving rural or marginalized populations, ultimately undermining the inclusive goals of digital transformation.

As institutions progress through the DTMM-Africa model, data becomes increasingly central to decision-making, customer engagement, and ecosystem integration. However, data governance and interoperability remain persistent barriers in African financial ecosystems. Most institutions lack comprehensive data management strategies, resulting in issues such as poor data quality, inconsistent formats, siloed databases, and weak security protocols.

The absence of robust data protection regulations or inconsistent enforcement mechanisms further complicates data governance. While countries like Kenya, Nigeria, and South Africa have enacted data protection laws, implementation remains weak, and many institutions lack compliance frameworks. This poses reputational and legal risks, especially as customer data becomes a core asset in AI-driven personalization and risk management tools.

Interoperability challenges also hinder ecosystem-level integration. Financial institutions, fintechs, and mobile money providers often operate proprietary platforms that do not communicate effectively with each other (Gomber *et al*., 2018; Blakstad and Allen, 2018). National payment systems, if present, are sometimes monopolized or lack standardized APIs and protocols. This limits the scalability and inclusiveness of digital financial services, as users are confined to closed networks that fail to leverage the benefits of a broader digital economy.

The lack of interoperability also impacts real-time credit scoring, fraud detection, and KYC verification, which rely on the seamless exchange of data across institutions and sectors. Without interoperable

frameworks, institutions cannot fully capitalize on the optimization and innovation stages of DTMM-Africa. Beyond technical and regulatory hurdles, organizational culture and resistance to change represent significant barriers to the implementation of digital transformation. Many financial institutions operate within hierarchical, risk-averse structures that are slow to adopt new technologies or operational models. Change management is often under-resourced or misunderstood, and digital initiatives are perceived as IT projects rather than organization-wide transformations.

This institutional inertia manifests in several ways: reluctance to reallocate budgets from traditional banking functions to digital innovation; fear of cannibalizing existing products; and internal politics that inhibit cross-departmental collaboration. Leadership may also lack the vision or digital literacy required to champion transformation, resulting in piecemeal or tokenistic efforts that fail to deliver systemic change (Radnor *et al*., 2016; Osgood and White, 2017).

Staff resistance is another common challenge. Employees often fear job displacement due to automation or feel overwhelmed by new digital tools. In environments where training and career development are limited, digital transformation can breed anxiety and disengagement, further slowing progress. Change fatigue, particularly in institutions facing constant regulatory shifts or donor-driven pilot programs, can erode morale and reduce implementation fidelity.

To address these issues, institutions need structured change management strategies, leadership development programs, and incentives that reward innovation and risk-taking. Without addressing the human and cultural dimensions of transformation, the most sophisticated maturity models will remain underutilized.

CONCLUSION AND FUTURE DIRECTIONS

The Digital Transformation Maturity Model for Africa (DTMM-Africa) represents a significant conceptual and practical contribution to the evolving landscape of banking and payments on the continent. By offering a structured five-stage progression—Initiation, Digitization, Integration, Optimization, and Innovation—grounded in core dimensions such as technology, data, governance, customer experience, and partnerships, DTMM-Africa provides a coherent framework for financial institutions to assess, plan, and accelerate their digital evolution. Importantly, it does so with contextual sensitivity to the infrastructural, regulatory, and socio-economic realities that characterize African financial systems.

One of the model's core contributions lies in its ability to guide structured innovation across heterogeneous institutions. In contrast to fragmented or ad hoc digital initiatives, DTMM-Africa emphasizes alignment, coordination, and progressive capability development. It offers a roadmap that supports institutions not only in adopting digital tools but in embedding them within organizational strategy and culture. This maturity-based approach helps stakeholders identify capability gaps, prioritize investments, and align with national and regional digital finance objectives, ultimately fostering a more coherent and interoperable ecosystem.

The strategic implications of DTMM-Africa are profound. As digital transformation becomes a defining axis of global financial competitiveness, African institutions that scale the maturity curve can secure significant competitive advantages. These include operational efficiencies, improved customer experiences, and the ability to offer agile, data-driven products tailored to underserved populations. For regulators and policymakers, digital maturity is a lever for strengthening systemic resilience, promoting responsible innovation, and deepening financial inclusion—particularly for informal workers, women, and rural populations.

Moreover, mature institutions are better equipped to navigate emerging challenges such as cyber threats, data localization demands, and platform competition. As global regulatory expectations around data privacy, open banking, and ethical AI intensify, digital maturity becomes essential not only for innovation but also for compliance and risk management.

Looking forward, there is a rich research agenda to deepen and expand the DTMM-Africa framework.

One priority area is the development of AI-driven infrastructure assessment tools that can dynamically map institutional and market readiness using real-time data sources such as API performance, mobile penetration, and transaction metadata. These tools could enable more responsive policy and investment decisions.

A second frontier involves the design of cross-border digital compliance models, particularly under initiatives like the African Continental Free Trade Area (AfCFTA) and Pan-African Payment and Settlement System (PAPSS). Harmonizing digital finance regulations across jurisdictions will require sophisticated policy modeling and interoperability testing.

Finally, future research should prioritize the creation of inclusive UX (user experience) frameworks that address the linguistic, cultural, and literacy diversity across Africa. Innovations such as voice-enabled interfaces, vernacular language support, and low-bandwidth platforms will be critical for ensuring that digital transformation remains equitable and empowering.

DTMM-Africa offers a foundational tool for unlocking Africa's digital financial future. Through continued refinement, research, and collaboration, it can serve as a catalyst for inclusive innovation, competitive resilience, and systemic transformation across the continent's financial landscape.

REFERENCES

[1] Abrahams, L., 2017. Regulatory imperatives for the future of SADC's" digital complexity ecosystem". *The African Journal of Information and Communication*, *20*, pp.1-29.

[2] Adenuga, T., Ayobami, A.T. & Okolo, F.C., 2019. Laying the Groundwork for Predictive Workforce Planning Through Strategic Data Analytics and Talent Modeling. IRE Journals, 3(3), pp.159–161. ISSN: 2456-8880.

[3] Ajonbadi, H.A., Lawal, A.A., Badmus, D.A. and Otokiti, B.O., 2014. Financial Control and Organisational Performance of the Nigerian Small and Medium Enterprises (SMEs): A Catalyst for Economic Growth. *American Journal of Business, Economics and Management. 2 (2), 135*, *143*.

[4] Ajonbadi, H.A., Otokiti, B.O. and Adebayo, P., 2016. The efficacy of planning on organisational performance in the Nigeria SMEs. *European Journal of Business and Management*, *24*(3), pp.25-47.

[5] AjonbadiAdeniyi, H., AboabaMojeed-Sanni, B. and Otokiti, B.O., 2015. Sustaining Competitive Advantage in Medium-sized Enterprises (MEs) through Employee Social Interaction and Helping Behaviours. *Journal of Small Business and Entrepreneurship*, *3*(2), pp.1-16.

[6] Akinbola, O.A. and Otoki, B.O., 2012. Effects of lease options as a source of finance on profitability performance of small and medium enterprises (SMEs) in Lagos State, Nigeria. *International Journal of Economic Development Research and Investment Vol. 3 No3, Dec 2012*.

[7] Anadon, L.D., Chan, G., Harley, A.G., Matus, K., Moon, S., Murthy, S.L. and Clark, W.C., 2016. Making technological innovation work for sustainable development. *Proceedings of the National Academy of Sciences*, *113*(35), pp.9682-9690.

[8] Arends, S.C. and Advisory, B.G.K.I., 2018. Development of a firm-level innovation capability maturity model and identification of innovation archetypes. *unpublished thesis, available at: https://pure. tue. nl/ws/files/108918087/Master_Thesis_Sophie_Arends. pdf*.

[9] Atick, J., 2016. Digital identity: the essential guide. In *ID4Africa identity forum* (Vol. 2016, pp. 1-3).

[10] Battleson, D.A., West, B.C., Kim, J., Ramesh, B. and Robinson, P.S., 2016. Achieving dynamic capabilities with cloud computing: An empirical investigation. *European Journal of Information Systems*, *25*(3), pp.209-230.

[11] Becker, S.A., Cummins, M., Davis, A., Freeman, A., Hall, C.G. and Ananthanarayanan,

V., 2017. *NMC horizon report: 2017 higher education edition* (pp. 1-60). The New Media Consortium.

[12] Benlian, A., Kettinger, W.J., Sunyaev, A., Winkler, T.J. and Guest Editors, 2018. The transformative value of cloud computing: a decoupling, platformization, and recombination theoretical framework. *Journal of management information systems*, *35*(3), pp.719-739.

[13] Best, J., 2018. *Breaking Digital Gridlock,+ Website: Improving Your Bank's Digital Future by Making Technology Changes Now*. John Wiley & Sons.

[14] Bhasin, M.L., 2016. The role of technology in combatting bank frauds: perspectives and prospects. *Ecoforum Journal*, *5*(2).

[15] Blakstad, S. and Allen, R., 2018. FinTech revolution. *Cham, Switzerland: Springer*, *121*, p.132.

[16] Bromberg, L., Godwin, A. and Ramsay, I., 2017. Fintech sandboxes: Achieving a balance between regulation and innovation. *Journal of Banking and Finance Law and Practice*, *28*(4), pp.314-336.

[17] Brummer, C. and Yadav, Y., 2018. Fintech and the innovation trilemma. *Geo. LJ*, *107*, p.235.

[18] Carmona, A.F., Lombardo, A.G.Q., Pastor, R.R., Quirós, C.T., García, J.V., Muñoz, D.R. and Martin, L.C., 2018. Competition issues in the area of financial technology (Fintech). *Policy Dep. Econ. Sci. Qual. Life Policies Eur. Parliam*.

[19] Charalabidis, Y., Zuiderwijk, A., Alexopoulos, C., Janssen, M., Höchtl, J. and Ferro, E., 2018. The world of open data. *Public Administration and Information Technology. Cham: Springer International Publishing. doi*, pp.978-3.

[20] Chiu, I.H., 2016. Fintech and disruptive business models in financial products, intermediation and markets-policy implications for financial regulators. *J. Tech. L. & Pol'y*, *21*, p.55.

[21] Chuen, D.L.K. and Deng, R.H., 2017. *Handbook of blockchain, digital finance, and inclusion: cryptocurrency, fintech, insurtech, regulation, Chinatech, mobile security, and distributed ledger*. Academic Press.

[22] Cooke, P., 2016. The virtues of variety in regional innovation systems and entrepreneurial ecosystems. *Journal of Open Innovation: Technology, Market, and Complexity*, *2*(3), pp.1-19.

[23] Creutzfeldt, N., 2016. A voice for change? Trust relationships between ombudsmen, individuals and public service providers. *Journal of Social Welfare and Family Law*, *38*(4), pp.460-479.

[24] Dandapani, K., 2017. Electronic finance–recent developments. *Managerial Finance*, *43*(5), pp.614-626.

[25] Davis, J.P., 2016. The group dynamics of interorganizational relationships: Collaborating with multiple partners in innovation ecosystems. *Administrative science quarterly*, *61*(4), pp.621-661.

[26] Domingo, A.I.S. and Enríquez, Á.M., 2018. Digital Identity: the current state of affairs. *BBVA research*, *1*(0), pp.1-46.

[27] Eimicke, W.B., 2018. The Process Case: The Digital Revolution and Telemedicine in India. In *Social Value Investing: A Management Framework for Effective Partnerships* (pp. 51-68). Columbia University Press.

[28] Fasnacht, D., 2018. Open innovation ecosystems. In *Open Innovation Ecosystems: Creating New Value Constellations in the Financial Services* (pp. 131-172). Cham: Springer International Publishing.

[29] Fasnacht, D., 2018. Open innovation in the financial services. In *Open innovation ecosystems: Creating new value constellations in the financial services* (pp. 97-130). Cham: Springer International Publishing.

[30] Fenwick, M., Vermeulen, E.P. and Corrales, M., 2018. Business and regulatory responses to artificial intelligence: Dynamic regulation, innovation ecosystems and the strategic

management of disruptive technology. *Robotics, AI and the Future of Law*, pp.81-103.

[31] Flott, K., Callahan, R., Darzi, A. and Mayer, E., 2016. A patient-centered framework for evaluating digital maturity of health services: a systematic review. *Journal of medical Internet research*, *18*(4), p.e75.

[32] Foth, M., 2017. Submission to the Inquiry by the House of Representatives Standing Committee on Infrastructure, Transport and Cities into the Australian Government's Role in the Development of Cities. *Submission No. 75*.

[33] George, G., Corbishley, C., Khayesi, J.N., Haas, M.R. and Tihanyi, L., 2016. Bringing Africa in: Promising directions for management research. *Academy of management journal*, *59*(2), pp.377-393.

[34] Gomber, P., Kauffman, R.J., Parker, C. and Weber, B.W., 2018. On the fintech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. *Journal of management information systems*, *35*(1), pp.220-265.

[35] Hameed, F., Agrafiotis, I., Weisser, C., Goldsmith, M. and Creese, S., 2018, September. Analysing trends and success factors of international cybersecurity capacity-building initiatives. In *Twelfth international conference on emerging security information, systems and technologies (SECURWARE 2018)*. International Academy, Research and Industry Association.

[36] Hamidi, S.R., Aziz, A.A., Shuhidan, S.M., Aziz, A.A. and Mokhsin, M., 2018. SMEs maturity model assessment of IR4. 0 digital transformation. In *Proceedings of the 7th International Conference on Kansei Engineering and Emotion Research 2018: KEER 2018, 19-22 March 2018, Kuching, Sarawak, Malaysia* (pp. 721-732). Springer Singapore.

[37] Hendrikse, R., Bassens, D. and Van Meeteren, M., 2018. The Appleization of finance: Charting incumbent finance's embrace of FinTech. *Finance and Society*, *4*(2), pp.159-180.

[38] Hohmann, M., Pirang, A. and Benner, T., 2017. Advancing Cybersecurity Capacity Building. *Global Public Policy Institute (GPPi)*.

[39] Igwe, P.A., Onjewu, A.E. and Nwibo, S.U., 2018. Entrepreneurship and SMEs' productivity challenges in sub-Saharan Africa. *African entrepreneurship: challenges and opportunities for doing business*, pp.189-221.

[40] Kim, J.E., 2018. Technological capacity building through energy aid: Empirical evidence from renewable energy sector. *Energy policy*, *122*, pp.449-458.

[41] Kolding, M., Sundblad, M., Alexa, J., Stone, M., Aravopoulou, E. and Evans, G., 2018. Information management–a skills gap?. *The Bottom Line*, *31*(3/4), pp.170-190.

[42] Kuriyama, C.A., Yuan, D.C.J., Sangaraju, D. and Sing, S.K.M., 2018. APEC's Bogor goals progress report. In *APEC's Bogor goals progress report: Kuriyama, Carlos A.| uYuan, Denise Cheok Jia| uSangaraju, Divya| uSing, Satvinderjit Kaur Manjit*. Singapore: APEC Policy Support Unit, Asia-Pacific Economic Cooperation.

[43] Lamberton, C., Brigo, D. and Hoy, D., 2017. Impact of Robotics, RPA and AI on the insurance industry: challenges and opportunities. *Journal of Financial Perspectives*, *4*(1).

[44] Langston, C. and Ghanbaripour, A.N., 2016. A Management Maturity Model (MMM) for project-based organisational performance assessment. *Construction Economics and Building*, *16*(4), pp.68-85.

[45] Lawal, A.A., Ajonbadi, H.A. and Otokiti, B.O., 2014. Leadership and organisational performance in the Nigeria small and medium enterprises (SMEs). *American Journal of Business, Economics and Management*, *2*(5), p.121.

[46] Lawal, A.A., Ajonbadi, H.A. and Otokiti, B.O., 2014. Strategic importance of the Nigerian small and medium enterprises (SMES): Myth or

reality. *American Journal of Business, Economics and Management*, *2*(4), pp.94-104.

[47] Li, J., Li, M., Gao, Y., Li, J., Su, H., Huang, M., Li, J., Li, M., Gao, Y., Li, J. and Su, H., 2018. National Level: Key Areas and Strategic Breakthroughs for Enhancing China's Overall Economic Competitiveness. *China's Provincial Economic Competitiveness and Policy Outlook for the 13th Five-year Plan Period (2016-2020)*, pp.105-133.

[48] Megargel, A., Shankararaman, V. and Fan, T.P., 2018. SOA maturity influence on digital banking transformation. *IDRBT Journal of Banking Technology*, *2*(2), p.1.

[49] Mittal, S., Khan, M.A., Romero, D. and Wuest, T., 2018. A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and medium-sized enterprises (SMEs). *Journal of manufacturing systems*, *49*, pp.194-214.

[50] Ndemo, B. and Weiss, T., 2017. Making sense of Africa's emerging digital transformation and its many futures. *Africa Journal of Management*, *3*(3-4), pp.328-347.

[51] Ng'ambi, D., Brown, C., Bozalek, V., Gachago, D. and Wood, D., 2016. Technology enhanced teaching and learning in South African higher education–A rearview of a 20 year journey. *British Journal of Educational Technology*, *47*(5), pp.843-858.

[52] O'Neill, B.C., Kriegler, E., Ebi, K.L., Kemp-Benedict, E., Riahi, K., Rothman, D.S., Van Ruijven, B.J., Van Vuuren, D.P., Birkmann, J., Kok, K. and Levy, M., 2017. The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. *Global environmental change*, *42*, pp.169-180.

[53] Omarini, A.E., 2018. Fintech and the future of the payment landscape: the mobile wallet ecosystem. A challenge for retail banks?. *International Journal of Financial Research*, *9*(4), pp.97-116.

[54] Osano, H.M. and Languitone, H., 2016. Factors influencing access to finance by SMEs in Mozambique: case of SMEs in Maputo central business district. *Journal of innovation and entrepreneurship*, *5*, pp.1-16.

[55] Osgood, K. and White, D.E. eds., 2017. *Winning While Losing: Civil Rights, the Conservative Movement and the Presidency from Nixon to Obama*. University Press of Florida.

[56] Otokiti, B.O. and Akinbola, O.A., 2013. Effects of Lease Options on the Organizational Growth of Small and Medium Enterprise (SME's) in Lagos State, Nigeria. *Asian Journal of Business and Management Sciences*, *3*(4), pp.1-12.

[57] Otokiti, B.O. and Akorede, A.F., 2018. Advancing sustainability through change and innovation: A co-evolutionary perspective. *Innovation: Taking creativity to the market. Book of Readings in Honour of Professor SO Otokiti*, *1*(1), pp.161-167.

[58] Otokiti, B.O., 2012. *Mode of Entry of Multinational Corporation and their Performance in the Nigeria Market* (Doctoral dissertation, Covenant University).

[59] Otokiti, B.O., 2017. Social media and business growth of women entrepreneurs in Ilorin metropolis. *International Journal of Entrepreneurship, Business and Management*, *1*(2), pp.50-65.

[60] Otokiti, B.O., 2018. Business regulation and control in Nigeria. *Book of readings in honour of Professor SO Otokiti*, *1*(2), pp.201-215.

[61] Panetto, H., Zdravkovic, M., Jardim-Goncalves, R., Romero, D., Cecil, J. and Mezgár, I., 2016. New perspectives for the future interoperable enterprise systems. *Computers in industry*, *79*, pp.47-63.

[62] Radnor, Z.J., Bateman, N., Esain, A., Kumar, M., Williams, S.J. and Upton, D.M., 2016. *Public Service Operations Management*. Routledge.

[63] Revang, M., Baker, V., Manusama, B. and Mullen, A., 2018. Market guide for conversational platforms. *Technical report, Gartner, Tech. Rep.*

[64] SHARMA, A., ADEKUNLE, B.I., OGEAWUCHI, J.C., ABAYOMI, A.A. and ONIFADE, O., 2019. IoT-enabled Predictive Maintenance for Mechanical Systems: Innovations in Real-time Monitoring and Operational Excellence.

[65] Spigel, B., 2017. The relational organization of entrepreneurial ecosystems. *Entrepreneurship theory and practice*, *41*(1), pp.49-72.

[66] Staddon, C., Ward, S., De Vito, L., Zuniga-Teran, A., Gerlak, A.K., Schoeman, Y., Hart, A. and Booth, G., 2018. Contributions of green infrastructure to enhancing urban resilience. *Environment Systems and Decisions*, *38*, pp.330-338.

[67] Stevens, J.L., Spaid, B.I., Breazeale, M. and Jones, C.L.E., 2018. Timeliness, transparency, and trust: A framework for managing online customer complaints. *Business Horizons*, *61*(3), pp.375-384.

[68] Teece, D.J., 2017. Profiting from innovation in the digital economy: standards, complementary assets, and business models in the wireless world. *Research Policy (forthcoming)*.

[69] Turban, E., Pollard, C. and Wood, G., 2018. *Information technology for management: On-demand strategies for performance, growth and sustainability*. John Wiley & Sons.

[70] Tuzovic, S. and Paluch, S., 2018. Conversational commerce–a new era for service business development?. *Service Business Development: Strategien–Innovationen–GeschäftsmodelleBand 1*, pp.81-100.

[71] Wilson Jr, J.D., 2017. *Creating strategic value through financial technology*. John Wiley & Sons.

[72] Zalan, T. and Toufaily, E., 2017. The promise of fintech in emerging markets: Not as disruptive. *Contemporary Economics*, *11*(4), p.415.

[73] Zetzsche, D.A., Buckley, R.P., Barberis, J.N. and Arner, D.W., 2017. Regulating a revolution: from regulatory sandboxes to smart regulation. *Fordham J. Corp. & Fin. L.*, *23*, p.31.

[74] Zhang, T., Lu, C. and Kizildag, M., 2018. Banking "on-the-go": examining consumers' adoption of mobile banking services. *International Journal of Quality and Service Sciences*, *10*(3), pp.279-295.

[75] Zhao, E.Y. and Wry, T., 2016. Not all inequality is equal: Deconstructing the societal logic of patriarchy to understand microfinance lending to women. *Academy of management Journal*, *59*(6), pp.1994-2020.