

AITEK INNOVATION SUMMIT POLICY BRIEF 2024

“BUILDING AFRICA'S DIGITAL FUTURE”

BEN GELOUNE, Redda, PhD, MBA, Eng

Research Associate at Engaged Management Scholar
at Weatherhead Cleveland USA

Research Associate at Fowler Center for Business
Cleveland USA

CEO and Founder of AITEK Group Abidjan Côte d'Ivoire
www.aitek.fr / rx651@case.edu

DOSSO, Mafini, PhD, PMP®

President of the International Organization for
Innovation for Sustainable Territories and Industries
(OIITID)

Co-founder at GAÏA Intelligence Africa
Abidjan Côte d'Ivoire

www.oitid.org / mafini.dosso@thinktankers.org
<https://scholar.google.fr/citations?user=bTkFs7QAAAAJ&hl=fr>

Summary

This policy brief is based on the discussions and debates from the AITEK Innovation Summit 2024. It synthesizes and structures the main messages, further enriched by the authors' perspectives. It examines the current challenges of local ecosystems and highlights the opportunities that innovation and artificial intelligence (AI) offer for the competitiveness of African businesses. Recommendations are also proposed to guide public decisions and support initiatives aimed at enhancing the technological and innovative performance of startups, SMEs, and large companies in Côte d'Ivoire.

Keywords: innovation; AI technology; digital economy; business competitiveness; Côte d'Ivoire; Ivory Coast

Acknowledgments and Citation Format

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Note: Any unintentional omissions, as well as any opinions or reflections expressed in this brief, are the sole responsibility of the authors and cannot be attributed to any participant, reviewer, or summit partner. However, the authors cannot be held responsible for any interpretations made of this brief.

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Introduction: Innovation and Technology for Economic Growth and Industrial Development in Côte d'Ivoire (Ivory Coast).

Côte d'Ivoire is now positioning itself among the continent's leaders in terms of connectivity, with mobile telephony and mobile internet penetration rates reaching 172% and 93%, respectively, in 2023. These achievements have spurred the growth of digital services, deeply transforming consumer habits and modes of learning, production, and distribution.

Public services (water, electricity), telecommunications, banking, and insurance sectors have had to adapt their business models to broaden inclusion and better serve the population. In the industrial sector, adoption has been slower, but Ivorian companies are gradually becoming aware of the importance of technology and innovation for their competitiveness. The current gaps are mainly due to insufficient investments, limited organizational changes, the absence of a critical mass, and a lack of qualified human capital; these aspects are essential for innovating and effectively integrating new technologies into business processes.

Although the fabric of SMEs and the ecosystem of Ivorian startups show signs of improvement in the adoption of digital technologies, the opportunities offered by innovation, particularly artificial intelligence (AI), remain under-exploited. This limits modernization prospects in key sectors such as agriculture, agro-industry, industrial transformation, transport, energy, public services, business services, education, health, and cultural, historical, and natural heritage management.

The challenges to be addressed are numerous: the quality and stability of energy, the lack of digital infrastructure reducing storage and computing capacity, limited access to financing and markets, and organizational models that do not evolve at the pace of technologies. Additionally, the scarcity of qualified talent, low employability, and resistance to change, both at the level of corporate governance and among employees, hinder the full adoption of digital innovations.

In this context of developing the digital economy and disseminating innovations and new technologies, this policy brief draws inspiration from the discussions held at the AITEK Innovation Summit 2024, which took place in Abidjan on July 5, 2024, under the theme "Building Africa's Digital Future."

Five panels brought together Ivorian and international experts from various fields, including the digital economy, innovation, ICT, artificial intelligence, finance, entrepreneurship, education and training, research, and cybersecurity. The discussions and key messages are analyzed in this document, which is structured around the following points:

- 1) Data as the cornerstone of artificial intelligence.
- 2) The importance of innovation surveys to inform public decision-making and strengthen business competitiveness.
- 3) The need for specific frameworks and tools to finance innovation.
- 4) The development of new open innovation frameworks between large companies and startups in Côte d'Ivoire.
- 5) The ethical challenges posed by AI, including data biases and decision-making.
- 6) The importance of an agile state in supporting innovative and competitive companies.
- 7) Data protection and the cybersecurity challenges of AI.
- 8) The role of AI in enhancing learning and educational capabilities.

1. Data as the Cornerstone of Artificial Intelligence

Artificial Intelligence (AI) fundamentally relies on the exploitation of vast volumes of varied data. These data, whether quantitative, qualitative, textual, visual, or structured, are the essential resources indispensable to the functioning of machine learning and data processing algorithms. The performance of AI models directly depends on the quality and quantity of available data and their relevance to the task at hand (Goodfellow, 2016). This intrinsic link between AI and data underscores the strategic importance of data management in contemporary

organizations. In summary, data play a central role. They are to AI what fuel is to nuclear energy production: the essential raw material that allows algorithms to function and produce meaningful results. Without data, artificial intelligence cannot learn, improve, or be deployed effectively (Ben Geloune, 2024b).

Productivity Gains and Efficiency

The adoption of AI in various industries has demonstrated significant productivity gains. Indeed, the automation of processes through AI reduces the time needed to process complex tasks, thereby increasing operational efficiency and enabling better time management (Brynjolfsson & McAfee, 2017). These technologies not only offer more refined data analysis but also increase real-time decision-making capabilities, which is essential for maintaining a competitive advantage in the market (Ben Geloune, 2024).

Return on Investment (ROI)

AI can also accelerate return on investment (ROI) by optimizing resources allocated to critical operations. For example, in insurance, AI automates risk assessment and pricing, reducing operational costs and improving the accuracy of forecasts. This automation not only reduces error margins but also generates substantial savings for companies, thus offering a favorable ROI in a short time (Heaton et al., 2017).¹

Use Cases and Organizational Impact

- **Insurance Sector:** AI has revolutionized cost assessment and pricing. The automation of underwriting and claims processes has led to a 30% reduction in processing times, while improving the accuracy of cost estimates (Davenport & Ronank, 2018).
- **Stock Trading:** AI-driven high-frequency algorithmic trading enables faster and more accurate market trend analysis, reducing the risk of fraud while increasing investment returns. AI can process massive volumes of stock data, allowing nearly 60% of market behaviors to be predicted with enhanced accuracy (Cartea et al., 2015).
- **Banking Sector:** In banking, AI analyzes transactions in real time, improving the quick and effective detection of fraud. Additionally, AI optimizes credit assessment, reducing processing times and increasing the accuracy of credit decisions.
- **Fraud Prevention and Embezzlement in Companies:** In environments where financial fraud and embezzlement are frequent, AI proves to be a key tool for detecting anomalies in transactions and behavior patterns. Through predictive analysis and real-time anomaly detection, companies can prevent large-scale fraud cases before they occur. This not only helps avoid significant financial losses but also strengthens compliance and risk management mechanisms. The savings generated from reducing fraud can be substantial, thus improving operational margins.

Data Management, a Central Issue

The issue of data management is at the heart of AI adoption. In Côte d'Ivoire and, more broadly, in Africa, it is crucial to clarify aspects related to data rights and ownership to ensure equitable and ethical technology development. Legislations must specify who owns the data and under what conditions they can be used by technology companies, particularly in the context of AI. Transparency and informed user consent must be the pillars of any data-related initiative to respect individual rights and ensure public trust.

Blockchain, an Emerging Technology for Decentralized Data Management

New technologies like blockchain enable more transparent and secure data management. By guaranteeing an immutable and traceable record of data transactions, blockchain is particularly useful in fields requiring high data reliability, such as supply chain management, healthcare, and finance. It ensures the security of exchanges

¹ See the discussion by BPI France on the topic at <https://bigmedia.bpifrance.fr/nos-dossiers/comment-lia-revolutionne-le-secteur-de-lassurance>

between stakeholders without traditional intermediaries and enhances the reliability of AI models by preserving the integrity of the data used for training.

Moreover, blockchain offers opportunities for distributed data ownership management, allowing SMEs and startups to retain control over their information, thereby promoting greater digital sovereignty and reducing dependence on large platforms.

Context of Côte d'Ivoire

In Côte d'Ivoire, AI adoption remains limited, as is the case in sectors such as insurance, banking, and healthcare, despite the availability of data. Numerous challenges remain, including restricted access to digital tools, which constitutes a major barrier to the adoption of these advanced technologies. Although there is growing interest from both the private and public sectors, no significant advances have yet been made. It is, therefore, imperative to quickly implement a national artificial intelligence strategy and prioritize the development of the supercomputer, whose foundation stone was laid in 2024. Integrating AI is not only crucial for staying competitive in the global digital economy but also represents a unique leapfrogging opportunity—meaning a technological leap that allows for achieving advanced levels of development without going through traditional intermediate stages (Ben Geloune, 2024a).²

2. The Importance of Innovation Surveys to Inform Public Decision-Making and Enhance Business Competitiveness

Innovation refers to the creation or introduction of new or significantly improved solutions. These solutions can take the form of products, services, business models, work organization methods, and marketing and/or procurement models.

Innovation surveys have strategic implications for decision-making in situations of uncertainty involving a wide variety of stakeholders. The governance of ecosystems and national innovation systems, which are complex networks of diverse actors, and the design of support instruments require frameworks and tools to measure innovation processes and their impacts.

Innovation surveys targeting companies aim primarily to better understand why and how companies of different sectors and sizes innovate and what the impacts are in terms of productivity, competitiveness, job creation, and growth. Conducting innovation surveys is not a new practice; it is already established in more developed countries in North America and Europe. At the African level, they are still uncommon, irregular, and limited to a handful of countries.

Internationally, the Oslo Manual provides guidelines, a common vocabulary, agreed principles, and practical conventions for collecting, reporting, and using data on innovation (OECD/Eurostat, 2018). To facilitate international comparisons, the manual and its progressive adaptations also reflect efforts to harmonize and take into account key trends in the socio-economic and technological environment (global value chains, new information technologies and business models, knowledge-based capital, etc.).

In the European Union, the reference survey on business innovation is the Community Innovation Survey (CIS). Conducted since the early 1990s, it is now carried out on a biennial basis, following a legal framework governing data quality and coverage, which considers different sectors, company sizes, and a variety of indicators. A harmonized or standardized questionnaire is developed for each cycle, targeting aspects such as product or

² In Côte d'Ivoire, only 38% of the population uses mobile internet, and about 5% of households have access to fixed broadband. (See the report published by the World Bank on the digital sector at <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099355005302211871/p177422081a7ac0b408ec30f8b1dd88ba40>).

D'autres pays d'Afrique de l'ouest, tels que le Bénin et le Sénégal ont déjà initié ou adopté leur stratégie nationale pour l'IA.

process innovation, development, innovation activities and expenditures, as well as sources of funding and barriers to innovation. The most recent survey covers the mining industry, manufacturing industries (food, textile, chemical, pharmaceutical, petroleum and pharmaceutical, electronic components, wood industry, furniture manufacturing, etc.), the supply of energy, water, gas, trade, transportation, ICT, as well as financial, study, and consulting activities.

In the United States, the 2009 BRDIS survey on business innovation was also inspired by the CIS of the European Union. However, these two surveys are not easily comparable due to differences in objectives, coverage, and contexts. Based on the 2018 Oslo Manual, the reference survey is now the "Annual Business Survey" (ABS), which provides a more comprehensive perspective on how nonprofit American businesses innovate. The 2020 ABS covers approximately 4.9 million companies.

In developing countries, several initiatives exist, including those led by the UNESCO Institute for Statistics (UIS Innovation data). The first survey was conducted in 2013, initiating a more regular collection covering over 70 countries. Among these, alongside several Latin American countries, are African countries such as Egypt, Ethiopia, Ghana, Kenya, Morocco, South Africa, Tanzania, and Uganda (UNESCO-UIS, 2017). The African Observatory of Science, Technology, and Innovation (AOSTI) is a specialized agency of the African Union dedicated to monitoring and measuring R&D and innovation activities to inform innovation policies across the African continent. Now coordinated by the AU-NEPAD and AOSTI, the "African Innovation Outlook (AIO)" surveys have progressively expanded their thematic coverage from R&D to innovation and their geographical reach. Indeed, the AIO 2010 covered 16 countries, while the most recent AIO 2019 extended to over 21 countries. In Francophone West Africa, Burkina Faso, Mali, and Senegal have participated in all three waves, whereas Côte d'Ivoire, a key economy in the sub-region, has not yet appeared in these strategic innovation surveys (AU-NEPAD, 2019). Finally, these surveys can target sectors considered key, groups of technology-oriented companies, or intermediary actors in the innovation system (Dosso, 2022b; Dosso et al., 2021).

The survey conducted by Dosso and published in the Global Innovation Index serves as an illustration of the potential of Ivorian tech startups. It also highlights the relevance of conducting dedicated surveys on these innovative, technology-focused companies with high growth potential. This survey collected information on i) the nature and determinants of the innovation processes of startups in Côte d'Ivoire; ii) the barriers or obstacles to innovation faced by startups in Côte d'Ivoire; and iii) the perceived impacts on the economy, society, and the environment (Dosso, 2022a). Conducted and published regularly, these surveys provide strategic data for:

- the design of appropriate instruments to support innovation;
- the evaluation of the impacts of funding and support programs for innovation in the short, medium, and long term;
- the comparison of national and sectoral innovation performance of Ivorian companies with other regional innovation leaders;
- business decision-making in terms of market opportunities (estimating potential) and commercial segmentation, as well as investments in innovative solutions or technical or organizational improvements;
- investment decisions, particularly in terms of venture capital aimed at tech startups;
- the visibility and attractiveness of Côte d'Ivoire's technological innovation ecosystem.

3. The Need for Specific Frameworks and Instruments to Finance Innovation

Although, by definition, innovation always incorporates a degree of novelty, it is important to emphasize that this novelty is relative: innovation can be new to the world or to the targeted market, or it may only be new to the company deploying it (it has already been implemented by one or more companies in different markets). This distinguishes companies that adopt and/or adapt existing innovations from those that develop innovations internally (OECD 2009). Surveys from the African Observatory of Science, Technology, and Innovation suggest that the acquisition of equipment or the adoption of existing technologies are the preferred modes of innovation for companies on the continent.

Due to its novel character for the targeted market, innovation involves a series of risks that are difficult to assess and cover using traditional financing models or approaches (such as bank loans). The limited funding availability constitutes a major obstacle to the development and dissemination of innovations, especially for startups or young innovative companies. In addition to external factors, the financial constraints of (young) innovative African companies are varied and depend on the following characteristics: sector, company size, age, stage of development, possession of collateral, and governance practices (Ayalew & Xianzhi, 2020; Iacovone et al., 2014). They may also result from limited access to information on funding opportunities for innovation and access or selection criteria.

Cornelius identifies two key dimensions for establishing a taxonomy of innovation financing: the age and maturity of the company and the position of the financing within the company's capital structure (Cornelius, 2020). Six phases are distinguished: seed, startup, expansion, later stage, growth, and maturity. The table below summarizes the correspondence between the company's life cycle and funding sources.

Table 1. Examples of Funding Sources According to the Development Stage of Startups

Seed and Startup	Expansion, Later Stage, and Growth	Maturity
Personal/family savings Public grants Philanthropy Reward-based crowdfunding	Retained earnings	Retained earnings
Friends and family Credit card debts Microcredit P2P/marketplace lending Fintech balance sheet loans Government loans Corporate debt	Government loans Corporate debt Bank loans Trade credit Private credit funds	Government loans Corporate debt Bank loans Trade credit Private credit funds Leveraged loans Subordinated/mezzanine debt Corporate bonds
Accelerators Crowdfunding Business Angels Independent venture capital firms Corporate venture capital Government venture capital	Independent venture capital firms Corporate venture capital Government venture capital	Non-traditional venture capital Growth funds Private equity Private equity Private placements/PIPE

Source: Translated from Cornelius (2020)

Note - Sources or types: Proprietary or non-debt/equity in black; Debt in blue; Equity: venture capital/private equity in brown.

4. Large Companies and Startups in Côte d'Ivoire: Developing New Open Innovation Frameworks?

Open innovation refers to the opening of internal innovation processes within companies to external parties, generating bidirectional flows of information and/or resources. This intentional process aims to accelerate internal innovation and its introduction and diffusion in the market (Chesbrough et al., 2006; Chesbrough, 2003). These flows can be temporary or long-term and take various organizational forms, such as collaborative projects, the formation of joint ventures, or even partial or complete integrations. Pecuniary or non-pecuniary in nature, interactions in open innovation models can also be structured through (partially) open, collaborative innovation platforms, which large companies can deploy. These models offer several advantages, including access to expertise and ideas, reduced costs, greater flexibility, and faster market access.

Most of the existing research focuses on modes of open innovation as implemented by large companies or multinationals originating from developed countries (de Paulo et al., 2017). These companies adapt their innovation modes in response to increasing globalization, more intense competition, the rapid pace of innovation cycles, and the growing complexity of associated processes. According to the literature review by Huizingh, approaches can be categorized along two dimensions: the innovation process, which can be open or closed, and the product or outcome, which can also be open or closed. Four types of innovation paths are thus identifiable: closed innovation, private open innovation (open process and closed product), public innovation (closed process and open product), and open-source innovation (open process and open product) (Huizingh, 2011). These types have different implications depending on the nature of the organizational arrangements that support interactions and the potential losses and gains for the parties involved before, during, and after the collaboration.

Research on open innovation practices in large companies in West Africa is still very limited. However, there are collaboration frameworks, partial technological integrations, or scouting initiatives orchestrated by large companies. These companies operate in various sectors, such as telecommunications and mobile service provision, logistics, and banking and insurance. Interactions and collaborations between large companies and young startups are rapidly developing in Côte d'Ivoire. However, they remain under-studied, limiting the understanding of underlying dynamics and the impacts on the performance of large companies and the growth of the startups involved.

A key factor in the collaboration between large companies and startups is the existence of a business opportunity. Depending on its challenges and market prospects, the large company relies on the startup, and the ecosystem in general, to develop new services; it leverages collective intelligence while providing technical support and/or financial investment to the startup. The process generally involves calls for applications, thorough due diligence, and presentations before one or more panels. The large company can act as a client or co-develop the offering with the startup(s). It may also provide decision-making tools that enable startups to discover new growth opportunities.

However, many questions remain unanswered, including the following, to name a few: What types of contractual arrangements or partnership conditions support collaborations between large companies and startups in Côte d'Ivoire? What are the costs and benefits for the large company? What are the success and failure factors? What are the impacts on the development of startups in terms of value creation and capture, the types of jobs they generate, revenue growth, survival rates, etc.? What are the conditions for replicability across different sectoral and organizational contexts?

5. Ethical Challenges Posed by AI, Including Data and Decision-Making Biases.

The increasing integration of artificial intelligence (AI) in various sectors raises complex ethical questions, which vary depending on the types of AI models used. Potential biases in data and decision-making within AI-integrated systems are among the main causes of ethical and societal issues, setting them apart from other automation technologies (Ben Geloune, 2023).

Types of AI Models and Ethical Challenges

- **Rule-Based AI:** Rule-based AI systems, like those used in chatbots, are characterized by their ability to perform repetitive tasks with high accuracy. However, while useful, these systems are limited by their inability to understand nuanced contexts or adapt to unexpected situations, which can lead to ethically problematic decisions due to their rigidity (Russell, 2016).
- **Weak AI:** Weak AI, which focuses on specific tasks such as creditworthiness analysis in banking transactions, presents ethical risks due to its reliance on predictive models based on historical data. These systems can perpetuate existing inequalities by embedding implicit biases into financial decisions (O'Neil, 2017).
- **General AI:** General AI, which relies on deep learning and complex statistical models, raises more significant ethical concerns due to its ability to understand diverse contexts and learn autonomously. Although effective, these systems are more susceptible to algorithmic biases and non-transparent decision-making, increasing the risks of unintended consequences (Bostrom & Yudkowsky, 2018).³

AI and Algorithmic Bias

Algorithmic biases are one of the main ethical challenges of AI. To reduce these biases, software developers must adopt several measures. It is crucial to start by auditing and cleaning the data used to train models, as biased data will inevitably lead to biased outcomes (Mehrabi et al., 2021). Additionally, including data from diverse populations, geographical areas, and types of transactions helps to better reflect reality and limit selection biases. Finally, it is essential to make models explainable to build user trust in the decisions made by these systems. The models should also be continuously updated with new data to adapt to changes and prevent decision obsolescence. To combat these risks, it is imperative to implement regular audits of algorithms and data collection processes to detect and correct biases.

AI and Personal Data Protection

The protection of personal data is a central issue in AI ethics. Companies that develop their AI applications internally are often better positioned to control data flows and reduce the risks of sensitive information leaks (Binns, 2018). Additionally, regular training on data protection is essential to keep employees informed of best practices in security. In Côte d'Ivoire, companies must comply with local regulations, such as those issued by the Telecommunications/ICT Regulatory Authority (ARTCI), as well as international standards like the General Data Protection Regulation (GDPR) for European subsidiaries.

IA and Employment

The impact of AI on employment is ambivalent. On the one hand, digitization and process automation have led to the elimination of certain jobs, especially in the manufacturing and administrative sectors (Acemoglu & Restrepo, 2018). However, in Africa, the industries most affected by these technologies do not yet dominate the

³ It should be noted that we can also distinguish Artificial Superintelligence (ASI), which is a hypothetical artificial intelligence (AI) software system with intellectual capabilities that surpass human intelligence. At the most fundamental level, this superintelligent AI possesses advanced cognitive functions and extremely developed reasoning skills, more advanced than those of any human being. (https://www.ibm.com/topics/artificial-superintelligence?mhsrc=ibmsearch_a&mhq=superintelligence)

economy. This presents a unique opportunity for the continent to use AI and large language models (LLM) to address its specific challenges (Ben Geloune, 2023).

On the other hand, the emergence of new sectors is creating a growing demand for specialized skills in developing, managing, and maintaining AI systems. However, the imbalance between the supply and demand for these skills remains a major challenge, especially in Africa, where a lack of adequate training hinders the optimal use of these technologies (Chui et al., 2016). In Côte d'Ivoire, the number of students trained in these fields will not be enough to meet the growing market needs. It would, therefore, be strategic to consider partnerships with specialized technology and educational platforms to strengthen local capacities and ensure faster and more effective skill development.

6. The Importance of an Agile State to Support Innovative and Competitive Companies.

The government has adopted several plans and reforms that have helped position Côte d'Ivoire among the high-growth African countries. Aligned with the United Nations 2030 Agenda, these initiatives and plans highlight the key role of SMEs and startups, or young innovative companies, in the structural transformation of the Ivorian economy, including the modernization of existing activities and the development of higher value-added activities. The National Development Plan of Côte d'Ivoire 2021-2025 (PND) explicitly mentions their potential in terms of value creation, employment, and contribution to the development of the Ivorian digital economy.

At the supranational institutional level, Côte d'Ivoire adopted the research and innovation policy of ECOWAS member states in 2012, and the African Science, Technology, and Innovation Strategy (STISA) was adopted by African countries for the decade 2014-2024 (AU, 2014). Progress reports exist, but the lack of funding, infrastructure, and human capital makes it difficult to see "the light at the end of the tunnel" at this time.

The Digital Startup Promotion Law is also a positive signal for the transformation of innovation ecosystems in Côte d'Ivoire. The country is one of the first in Francophone West Africa, after Senegal, to adopt specific legal provisions for this type of startup (Dosso, 2024). Although efforts are being made to initiate its full implementation, the lack of expert human resources and financial means poses significant risks to the viability of the process, raising questions about the approach taken to prioritize the efforts deployed.

In Côte d'Ivoire, the financing of startups is gradually developing and comes from various sources, including national and regional grants, development agency funds, investment funds, venture capital funds, "Love Money" (family and friends), and crowdfunding platforms. At the governmental level, initiatives are being put in place, for example, in the form of grants, low-interest loans, and support or reward programs for startups and holders of innovative projects. However, these funding opportunities are far from meeting the growing and specific needs of the innovation processes of Ivorian startups; furthermore, their sustainability is far from guaranteed.

In addition to funding, startups face informational barriers related to the market, sectoral practices, information on funding, and non-financial assistance programs. Added to this are the difficulties in establishing and stabilizing cooperations or partnerships within the ecosystem. Finally, companies emphasize the difficulty in finding and retaining the necessary talent for their development and growth.

In the face of these challenges, policymakers can activate several levers to accelerate the growth of innovative and high-value-added companies. These levers include, but are not limited to:

- Allocating resources and capacities for a coherent implementation of the Digital Startup Promotion Law;
- Establishing a clear roadmap to align the effectively available institutional resources with the efforts and activities deployed to strengthen innovation and startup ecosystems;
- Providing a regularly updated database of innovative and high-growth potential companies;

- Developing a more favorable investment framework for technological and non-technological innovation and supporting the creation of local and specialized investment funds (venture capital, private equity);
- Strengthening support for multi-stakeholder platforms focused on innovation and technology;
- Enhancing the quality and reach of financial markets for innovation and technological development;
- Providing macroeconomic indicators on national innovation performance (annual research, development, and innovation expenditures, researchers and inventors by sector, thematic indicators related to STEM, gender, environment, etc.) and strengthening the monitoring of developments in local innovation ecosystems.

7. Data Protection and AI Challenges in Cybersecurity.

The integration of artificial intelligence (AI) in cybersecurity has transformed the protection of information systems and data, enabling major advances in detecting and neutralizing cyber threats. Thanks to its ability to simulate human cognitive functions such as perception, computation, and decision-making, AI plays a key role in proactively identifying threats and improving responses to cyberattacks. However, this evolution brings new ethical, organizational, and technical challenges (Von Solms & Van Niekerk, 2013), especially as the rapid diffusion of digital technologies exacerbates system vulnerabilities.

Digital Diffusion and Vulnerabilities

The expansion of digital technologies has multiplied entry points for cyberattacks, making robust protection mechanisms indispensable. AI contributes significantly by enabling early threat detection and rapid response. However, challenges such as data sovereignty and ownership and the development of locally adapted AI models remain crucial, especially in Africa, where data storage and processing capacities are still limited.

Current AI Cybersecurity Challenges in Local Contexts

- **Data Sovereignty and Ownership:** The protection of personal data and digital sovereignty are critical issues. Developing AI models based on local data is essential to ensure that cybersecurity systems meet the specific needs of regions. However, Africa's storage capacities represent only 1.3% of the global supply, a figure comparable to that of Switzerland, which weakens the continent's digital sovereignty.
- **Financial Losses Due to Cybercrime:** Cybercrime is a major financial threat to African economies, causing estimated losses of \$4 billion annually, or about 10% of the continent's GDP. This situation is exacerbated by the widespread use of unlicensed software in administrations, exposing systems to increased vulnerabilities. It is, therefore, imperative to strengthen cybersecurity culture by encouraging the use of legitimate and secure software.
- **Data Confidentiality and Integrity:** Ensuring data confidentiality and integrity is a strategic priority. AI plays an essential role in detecting anomalies in data flows and providing continuous monitoring to prevent security breaches (Goodman, 2015). However, Africa still needs to overcome significant gaps, particularly in training and investments in research and development (R&D).
- **Training and Brain Drain:** The lack of specialized cybersecurity talent, combined with brain drain, significantly hinders the development of robust cybersecurity solutions on the continent. Training talent and retaining skills are, therefore, essential to strengthen the resilience of African digital systems. The state must ensure that the number of trained experts can meet demand, which is not the case today.
- **Structural and Regulatory Challenges:** The absence of African champions in the fields of AI and cybersecurity and the dependence on major global technology companies (GAFAM: Google, Apple, Facebook, Amazon, Microsoft) pose a major obstacle to digital sovereignty (Zuboff, 2023).

Administrative burdens and the still limited interest of African experts in these fields also hinder the development of locally adapted solutions.

- **Data Storage and Backup:** The majority of African data is stored abroad. The continent has only about 80 of the world's 8,000 data centers, posing significant national security and data sovereignty risks. In Côte d'Ivoire, agreements with the Telecommunications/ICT Regulatory Authority (ARTCI) allow for a combination of local and foreign hosting, but local capacities remain insufficient to ensure optimal data protection.

National Strategy and Cybersecurity in Côte d'Ivoire

In 2021, Côte d'Ivoire adopted a national digital strategy that includes specific cybersecurity and digital trust components. This strategy is supported by 32 reforms and 96 projects, including 21 directly related to cybersecurity and is based on seven pillars to strengthen the country's digital resilience. Among the important initiatives, creating a national data center and a thematic agency dedicated to cybersecurity demonstrates Côte d'Ivoire's commitment to this field. However, challenges remain, particularly regarding the training of talent and the mobilization of financial resources necessary to fully implement this strategy.⁴

8. The Role of AI in Enhancing Learning and Pedagogy

Access to technology is part of the right to education: "In particular, the implementation of the right to education must meet the needs of every person to access, master, and use technologies as they represent an empowerment tool enabling active participation in society." (Special Rapporteur on the right to education).

Adopting digital technologies has substantially changed learning and teaching methods in more advanced countries. Internet access has also provided access to universal knowledge and learning facilitation tools. The benefits of new technologies for education are numerous and include:

- Reducing the workload of teachers, allowing the time saved to be allocated to alternative tasks, including greater attention to children;
- Interactive and collaborative learning;
- Adaptation of discourse and pedagogical strategies;
- Greater personalization of training;
- More flexibility for teachers in designing their teaching resources;
- Integration of playful elements to increase learners' concentration and engagement.

⁴ See National Cybersecurity Strategy 2021-2025, Ministry of Digital Economy, Telecommunications, and Innovation <https://telecom.gouv.ci/new/uploads/publications/171137214933.pdf>

Box 1. The Large-Scale Introduction of AI in Digital Textbooks in Primary, Middle, and High Schools in South Korea (Asia)

The South Korean government plans to invest more than \$65 million to strengthen infrastructure and the availability of digital textbooks in its public education system.

Targeting primary, middle, and high schools, the government aims to facilitate the administrative and infrastructure management tasks of schools and teachers. To prepare for the use of AI-powered digital textbooks, the Ministry of Education plans to improve network conditions (internet speed and access obstacles).

In terms of human resources, South Korea plans to set up over a thousand "digital tutors" to support repair or equipment installation tasks, as well as technical support centers in metropolitan education offices to ease teachers' work and address malfunction issues. Additionally, the government will establish guidelines on standards, procedures, and common methods for each stage, from the provision of digital devices to their maintenance and disposal, and will support the safe management of devices to prevent students' overexposure to digital media and block harmful information.

(Source: Translated and synthesized from <https://www.koreatechtoday.com/south-koreas-70-million-investment-in-ai-powered-learning/#:~:text=The%20South%20Korean%20government%20has,be%20fully%20implemented%20next%20year>)

In Africa, the diffusion of digital technologies in education has been accelerated, notably by COVID-19, reduced travel, and the impetus of a number of local or continental initiatives. EdTech startups and entrepreneurs offer many educational solutions that can support targeted training, for example, towards cocoa producers, village housewives, or women in agriculture. Entrepreneurs also share social responsibility and can help bridge the accumulated educational gaps. Partnerships with large companies or hardware and software professionals can also support the establishment of multimedia centers, as is already visible. The democratization of computer education programs combined with entrepreneurship training would offer greater opportunities for creating and developing tech startups, fostering intergenerational interactions, and alleviating employability issues.

The widespread use of technology in classrooms and the education system requires thoughtful consideration of technology and a vision for education. Indeed, many challenges remain, including:

- The risk of educational exclusion due to a lack of access to new technologies;
- Low employability of young people and a mismatch between training and (new) jobs;
- The education system suffers from a decline in learning and concentration capacity due to excessive use of social networks for other purposes. Changes in family structure can also explain these trends.
- The issue of brain drain and the difficulty of retaining qualified or internally trained profiles.
- Limited access to the internet and equipment (computers, tablets, smart TVs in classrooms) in educational spaces.
- Technological infrastructure needs to be established and strengthened to optimize digital and AI-based learning.

Despite ongoing efforts, Côte d'Ivoire is not exempt from these trends and lags behind in integrating new technologies in education. The availability of quality internet access, equipment, and multimedia tools (hardware and software) remains very unevenly distributed across regions or cities. Additionally, there are intergenerational gaps: while technology is better assimilated by the younger population, there is a significant lag when it comes to the effectively active population. This is visible in the gap observed in using and mastering office tools such as Word and Excel, skills that are now essential for increased employability. Finally, alongside

the shortage of primary schools and teachers, there are gaps in the training of trainers, access to stable electricity, and issues related to illiteracy, all of which hinder the absorption and diffusion of technologies.

There are many possibilities for adapting the transmission of concepts to target learners using AI algorithms. Thus, it would be possible to adapt content and transmission modes to different local contexts in the medium and long term. Finally, given the specificities of our ecosystems, it is advisable to make complementary and smarter use of available resources, such as wireless networks (TV and radio), to innovate in education. Engineering resources in Côte d'Ivoire and West Africa could be mobilized to set up educational programs using television, SMS, and USSD technology, among others. International thematic organizations and civil society can support such programs and contribute based on their experiences in various socio-cultural and educational environments.

9. Concluding Remarks

Innovation and technology require significant capital, which is often more patient and sometimes sovereign, depending on the strategic aspects of the sectors or domains in question. In this perspective, it is urgent to conduct more structured reflections on mobilizing resources and attracting private Ivorian and African capital for innovative SMEs and startups. These reflections are especially relevant in a continent where more than 50% of agricultural production is wasted, and over 80% of transactions are still carried out in cash. This same continent hosts about half of the world's mobile money accounts.

Recent developments in innovation and startup ecosystems in Côte d'Ivoire confirm the new trajectory of the Ivorian economy. This trajectory is geared towards modernizing the economic and industrial fabric, which could be hindered if the public and private sectors fail to absorb appropriate technologies, particularly artificial intelligence (AI). This requires not only the adoption of new management and business models but also innovative and contextualized organizational modes.

Indeed, AI offers an exceptional opportunity to accelerate this modernization, but it necessitates the implementation of several actions, such as establishing a national AI strategy, developing and retaining talent, investing in digital infrastructure, creating a regulatory framework for ethical AI, supporting open innovation, and promoting local use cases.

This implies that technological transformation strategies should also give greater importance to other dimensions, such as customer relations and building trust, the quality of the solutions offered, their replicability across different sectors, and their ease of use. These dimensions are equally essential for democratizing the use of new technologies within our companies, organizations, administrations, and communities.

As illustrated by this policy brief, the opportunities offered by innovation and technology, including AI, are numerous, but so are the uncertainties. Côte d'Ivoire has an incredible pool of talents filled with creativity and innovativeness. Our ability to nurture and bring them to the forefront of our economy's transformation trajectory will undoubtedly shape the industrial and technological future of the Ivorian Nation.

Glossary

Black Hacker: Malicious hacker who exploits system vulnerabilities for personal gain or to cause harm, often illegally.

Blockchain: Distributed ledger technology that records transactions securely, transparently, and immutably, often used for cryptocurrencies and smart contracts.

ChatBots: Computer programs designed to simulate human conversations, often used for customer support, messaging services, and online interaction.

ChatGPT: Language model developed by OpenAI, based on the GPT (Generative Pre-trained Transformer) architecture, capable of generating text in a conversational manner and answering a variety of questions.

Cyberattacks: Malicious attempts to disrupt, damage, or illegally access a computer system or data.

Cyberd efense: Set of measures taken to protect information systems and critical infrastructures against cyberattacks, often on a national or institutional scale.

Cybersecurity: Set of practices, technologies, and processes aimed at protecting computer systems, networks, and data against unauthorized access, cyberattacks, and damage.

Datacenter: Physical facility housing servers and data storage equipment, ensuring the management, processing, and backup of an organization's or service's data.

Deep Learning: Subset of machine learning that uses deep neural networks to analyze complex data, such as images and text, and perform tasks like speech recognition.

Drones: Unmanned aerial vehicles (UAVs) remotely controlled or autonomous, used for various applications, including surveillance, mapping, agriculture, and logistics.

Editors: Companies or individuals that develop and distribute software, including AI systems, playing a key role in the security and performance of digital applications.

Innovation: Introduction of new solutions, products, services, processes, and/or methods that improve the way things are done, thereby creating economic or social value.

Artificial Intelligence (AI): Computer science discipline aimed at creating systems capable of simulating human cognitive functions, such as

learning, reasoning, and perception, using algorithms and mathematical models.

Internet of Things (IoT): Network of connected devices capable of collecting, exchanging, and analyzing data via the Internet, enabling automation and process improvement in various fields.

ISO Information Security: International standards (ISO/IEC 27001) defining best practices for information security management and the protection of computer systems.

Machine Learning: Subdomain of AI that allows systems to automatically learn and improve from experience without being explicitly programmed for each specific task.

Natural Language Processing (NLP): Branch of AI that enables machines to understand, interpret, and generate human language, facilitating interactions between humans and computers.

Neural Network: Computer model inspired by the functioning of the human brain, used in AI to recognize complex patterns in data, such as image or voice recognition.

Low Earth Orbit (LEO) Satellite Network: Network of satellites placed in low Earth orbit to provide communication services, such as high-speed Internet, even in remote areas.

Technological Sovereignty: The ability of a country or organization to control and master key technologies without relying on foreign actors, thereby ensuring security and technological autonomy.

Startup: Young and innovative company, often in the technology sector, with strong potential for rapid growth and impact on existing markets.

Technology and Technological Wave: Set of tools, systems, and methods based on recent scientific discoveries. A technological wave refers to a period of intense innovation in a specific field.

Digital Technologies: Digital technologies used to optimize operations across different sectors. These applications leverage data to improve efficiency, productivity, and sectoral innovation.

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Authors

Redda Ben Geloune is an entrepreneur and innovation expert, currently the CEO of AITEK (www.aitek.fr), a leading Ivorian technology company that has played a crucial role in the adoption of digital solutions across Africa for over 20 years. As the Director of the MBA Entrepreneurship and Innovation program at IFG, he trains future leaders in transformation and innovation strategies.

Holding a PhD from Case Western Reserve University, Redda is also an alumnus of Harvard Business School and a graduate of HEC Paris, institutions that have enabled him to develop a strategic vision of economic and technological dynamics in Africa. An associate researcher at the Fowler Center for Business and the EMS Center in Cleveland, he is dedicated to studying the impact of artificial intelligence on organizational performance.

His expertise is demonstrated through major contributions to international projects and the drafting of strategic notes for governments and institutions. A key figure in promoting artificial intelligence and innovation on the continent, he collaborates closely with leaders from the private sector and public sector decision-makers.

Passionate about technological disruptions, Redda actively engages in supporting the African entrepreneurial ecosystem, promoting high-impact solutions and sustainable development..

Dr Mafini Dosso obtained a PhD in industrial economics and innovation from the University Paris 1 Panthéon-Sorbonne (France) in 2012. Based in Abidjan, she is an international expert in industrial and innovation policy. An independent bank director (Comoros) and academic editor, she has over 18 years of experience, including 9 years as an Economist and then Project Manager at the European Commission in Spain.

President of the International Organization for Innovation in Sustainable Territories and Industries (OIITID: www.oiitid.org), she also co-founded GAÏA Intelligence Africa in 2019, the first Ivorian firm specializing in "Smart Specialization Strategies (S3)." She regularly conducts workshops for executives, leaders, and startups on intellectual property, innovation, and creativity for problem-solving. With the OEACP, she has worked on the innovation policy of Guinea (Conakry) and serves as an industrial policy consultant for UNCTAD.

Dr. Dosso is a certified Project Management Professional (PMP). Her areas of analysis include innovation policies for territories, technological and industrial change, and startups in Africa. An international speaker, she has more than 50 publications and over 100 presentations in English, French, and Spanish.

As a member of "Abidjanaises in Tech," Dr. Dosso is an alumna of the U.S. Department of State, Diaspora leader Africa 2.0 & Ashoka Spain, and Dream VC Investment Fellow.