UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

Science, technology and innovation parks development in Ghana

Assessment and policy issues

Technical cooperation outcome

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Abbreviations

AGI	Association of Ghana Industries
AU	African Union
CSIR	Council for Scientific and Industrial Research
CSIR-STEPRI	Ghana Council for Scientific and Industrial Research-Science and Technology Policy Research Institute
DTI	Design Technology Institute
ECOWAS	Economic Community of West African States
GAEC	Ghana Atomic Energy Commission
GDP	Gross Domestic Product
GCIC	Ghana Climate Innovation Center
GEXIM	Ghana Export Import Bank
GIH	Ghana Innovation Hub
GIPC	Ghana Investment Promotion Centre
GNCCI	Ghana National Chamber of Commerce & Industry
GRATIS	Ghana Regional Appropriate Technology Industrial Service
GSGDA	Ghana Shared Growth and Development Agenda
HEIs	Higher Education Institutions
IASP	International Association of Science Parks
ICT	Information and Communications Technology
IIR	Industrial Innovation Research
JICA	Japanese International Cooperation Agency
KIC	Kosmos Innovation Centre
MDF	Management for Development Foundation
MEST	Meltwater Entrepreneurial School of Technology
MESTI	Ministry of Environment, Science, Technology, Innovation
MOCD	Ministry of Communications and Digitisation
MoFF	Ministry of Finance
MOTI	Ministry of Trade and Industry
MSMEs	Micro-, Small and Medium-sized Enterprises
NEIP	National Entrepreneurship and Innovation Programme
PEF	Private Enterprise Federation
PPP	Public–Private Partnership
R&D	Research and Development

Abbreviations

SDGs	Sustainable Development Goals
STI	Science, Technology and Innovation
TCU	Technology Commercialization Unit
TVET	Technical and Vocational Education and Training
UN	United Nations
UNCTAD	United Nations Trade and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN-IATT	UN Inter-agency Task Team
UNIDO	United Nations Industrial Development Organization
UNPDF	United Nations Peace and Development Trust Fund

Executive summary

The 2030 Agenda for Sustainable Development acknowledges that Science, Technology and Innovation (STI) are vital drivers for enabling and accelerating the global shift towards prosperous, inclusive and environmentally sustainable economies. In this context, STI parks assume a significant role by bringing dynamism to national and regional innovation systems and promoting economic diversification and nurturing talents and skills. These parks offer a conducive environment for researchers, entrepreneurs and companies to collaborate, innovate and bring new technologies to the market. Thus, STI parks contribute to technological progress, job generation and the birth of new industries.

Funded by the 2030 Agenda for Sustainable Development Sub-Fund under the UN Peace and Development Trust Fund, the UNCTAD project on *Science, Technology and Innovation Parks for Sustainable Development: Building expertise in policy and practice in selected Asian and African countries* provides technical assistance to Ghana, Mongolia, Mozambique and Uzbekistan as pilot beneficiary countries. The project aims at bolstering expertise and augmenting capacity in these developing countries that will enable them to formulate effective, cohesive policies and institutional frameworks conducive to their STI parks' development, with a view to achieving sustainable development goals (SDGs).

Ghana, recognized for its political stability and burgeoning economic growth, is on the brink of an innovation renaissance. It has long recognized the imperative of a robust STI system as a foundation for its socio-economic development. According to the Global Innovation Index published by the World Intellectual Property Organization in 2022, Ghana performs above the African regional average in five areas: (1) human capital and research; (2) infrastructure; (3) business sophistication; (4) knowledge and technology outputs; and (5) creative outputs. Through various strategies and initiatives, the country has continually striven to enhance and fortify its STI system. Two of the most recent strategic initiatives are STI for SDGs Roadmap developed in collaboration with UNESCO as a member of the UN Inter-agency Task Team (UN-IATT) and the Ghanaian STI Policy 2024–2030 (hereinafter referred to as "2024 STI Policy"). In the STI for SDGs Roadmap, Ghana outlines an Ecosystem Development Plan that comprises the following:

- Improve or establish innovation systems and increasing the opportunity for knowledge transfer between multiple actors;
- Deepen entrepreneurial culture and mindset;
- Foster collaboration between private sector, universities and other research institutions;
- Introduce a Start-up Act to encourage and promote innovation and entrepreneurship; and
- Strengthen intellectual property laws to protect innovators and their innovations and encourage collaboration.

The 2024 STI Policy contains seven key action lines aimed at expanding the role of STI in Ghana's structural transformation for sustainable development:

1. Increase research and development investment to 1 per cent of gross domestic product (GDP) by 2030;
2. Facilitate industrialization by fostering innovation and technology adoption in key sectors;
3. Build human capacity to enhance STI capabilities;
4. Strengthen partnerships and collaboration amongst STI stakeholders;
5. Enhance sustainable environmental management practices that promote biodiversity restoration and conservation;
6. Foster adoption and application of frontier technologies; and
7. Integrate space science and technology into socio-economic sectors.

Well-functioning STI parks could be a useful implementing tool for the above two strategic initiatives. Ghana has set up various forms of STI parks, including university science parks, technology centres, innovation hubs, incubators, accelerators and ICT parks.

The assessment of the STI parks in Ghana, which combined literature reviews, policy reports, stakeholder questionnaires and on-site interviews, has led to the following findings:

1. STI parks play a crucial role in managing and influencing regional and national innovation ecosystems. They contribute to local, regional and national economic growth by diversifying the industrial base, creating jobs and fostering entrepreneurship. The parks serve as platforms for capacity-building, skills training and establishing partnerships between public and private sector.
2. The STI park ecosystem in Ghana is characterized by a well-developed policy environment that supports innovation and entrepreneurship, with the 2024 STI Policy providing a framework for the establishment and operation of STI parks. There is a growing interest in entrepreneurship, particularly within higher education institutions, which are becoming hubs for innovation. Emerging hotspots across the country, including cities like Accra and Kumasi, demonstrate the potential for diverse entrepreneurial activities, indicating a promising landscape for the future of STI parks in contributing to Ghana's socio-economic development.
3. Despite the potential of STI parks, several systemic challenges impede their effectiveness and growth. These include: implementation of the updated STI policy is slow and hampered by limited public awareness and inadequate funding; disconnect between R&D efforts and the commercialization potential within STI parks, compounded by weak coordination among government ministries and a lack of robust public-private partnerships; and insufficient infrastructure and support mechanisms to respond to the growing interest in STI parks from higher education institutions and the private sector, with many incubators lacking the necessary resources and expertise to effectively nurture innovation and entrepreneurship.

In summary, Ghana's STI parks face significant challenges that impede their effectiveness and growth. Addressing these challenges is crucial for unlocking the full potential of the STI park ecosystem in driving sustainable growth and innovation in the country.

The following recommendations have been proposed:

1. **Recommendations on STI policy:** speed up effective implementation rather than further policy improvements. The focus should be on supporting the execution of the 2024 STI Policy and developing robust monitoring and evaluation mechanisms to assess progress. Additionally, it is important to implement strategies that prioritize research and development investments, financing for STI projects and enhancing the management of STI parks to achieve the 2024 policy's objectives.
2. **Recommendations on institutional strengthening:** enhance the capacity of existing institutions to better support STI initiatives and improve collaboration among stakeholders. The focus should be on building a more cohesive network that can effectively drive innovation and entrepreneurship, ensuring that institutions are equipped with the necessary resources and expertise to fulfil their roles in the STI ecosystem.
3. **Recommendations to promote inclusivity:** ensure that STI initiatives are accessible to a broader range of participants, particularly marginalized groups, for overall effectiveness and impact of the STI initiatives. There should be policies and programmes that promote diversity and inclusion within the STI ecosystem, encouraging the participation of women, youth and underrepresented communities in innovation and entrepreneurship.
4. **Recommendations on capacity development:** equip individuals and organizations within the STI ecosystem with the skills and knowledge required to thrive. This includes targeted training programmes for entrepreneurs, researchers and policymakers to enhance their capabilities in innovation management, business development and technology commercialization.

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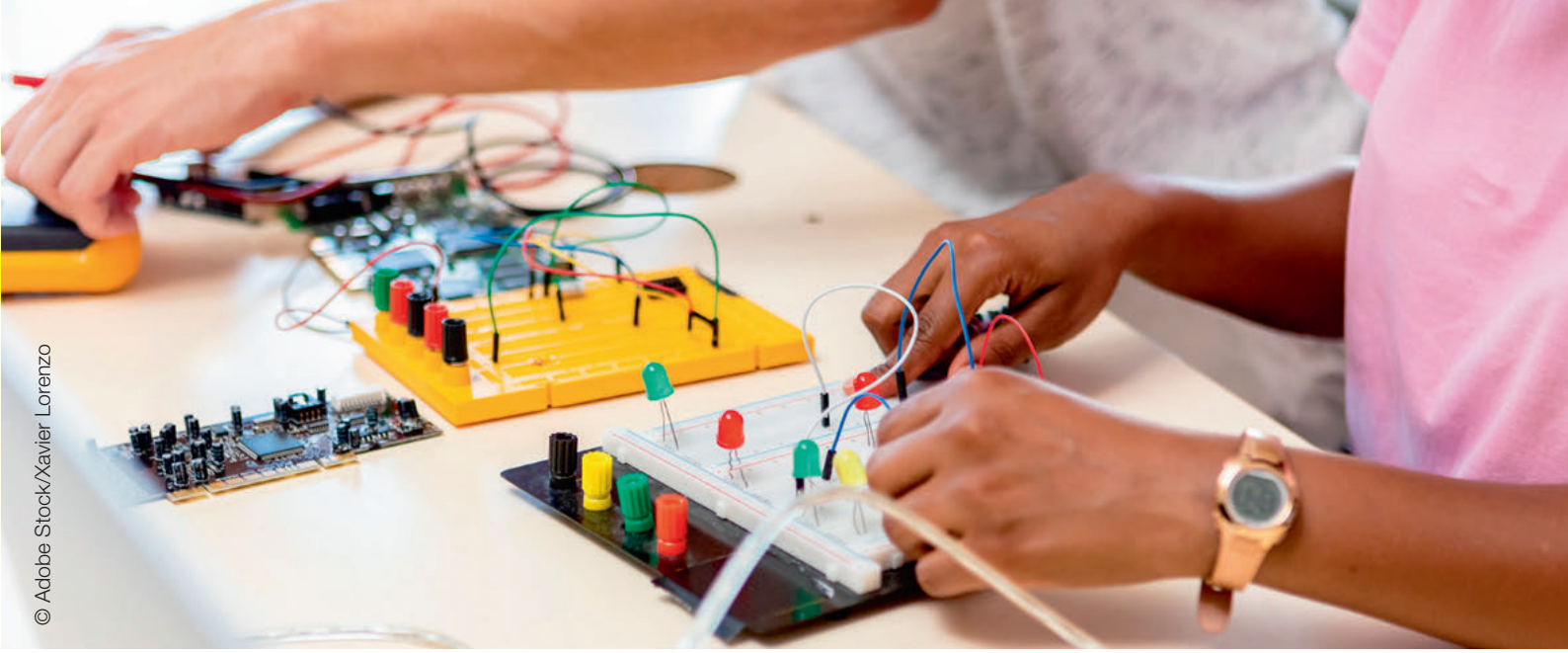

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I. Introduction to STI Parks

The assessment of science, technology and innovation parks in Ghana aims at identifying gaps and needed actions for leveraging such parks as effective socio-economic development policy instruments.

Science, Technology and Innovation Parks (STI Parks) are physical areas where multiple technology- or knowledge-intensive organizations co-locate to stimulate innovation based on research and development and leverage innovation and science or technology capabilities (UNCTAD, 2015). They are often referred to by different names such as innovation hubs, tech hubs, technopoles, research parks, science parks and in some cases, innovation clusters. These are organizations based on space or property, including high-tech clusters managed by professionals to achieve goals beyond just bringing businesses together in one location. STI parks are typically characterized by the co-location of multiple knowledge-intensive organizations including research institutes, to leverage each other's capabilities, knowledge and technology, based on the enabling environment provided (Ng et al., 2020). The main characteristic of STI parks is the concentration of enterprises and institutions engaged in developing, commercializing or manufacturing science or technology-intensive products or services, often including one or more business incubators and research centres (Adamaitis, 2021; Amoroso et al., 2019).

In this paper, science parks, science and technology parks, incubators, innovation hubs, accelerators and similar organizations such as industry parks promoting technology upgrading will be referred to as STI parks, given their shared objective of stimulating innovation and with the understanding that incubators and accelerators are instruments typically used by the STI parks to achieve their mandate.

The report aims to examine the state of the STI policy environment and STI parks in Ghana and highlights challenges, gaps and opportunities for the further development of the country's STI parks as effective socio-economic development policy instruments.

Broad definition of STI parks is used

II. STI Parks as a Development Instrument

STI parks promote national development by facilitating the flow of knowledge and technology, stimulating the creation and growth of innovation-based companies and providing customer-oriented services, including infrastructure.

STI parks are intended to achieve several goals. Firstly, STI parks contribute to the operationalization of a country's STI policies that aim at enhancing the country's STI capacity to harness the power of STI for national development, similar to what The Innovation Hub in South Africa was able to do in implementing the Gauteng Innovation Strategy, 2012 (Sibanda, 2021). In the case of The Innovation Hub, the Gauteng Provincial government tasked it to be the implementation agency of the Gauteng Innovation Strategy, which forced The Innovation Hub to develop a new organizational strategy that incorporated initiatives to implement the Gauteng Innovation Strategy, some of which had funding allocations from the provincial government. Today, the Innovation Hub has close collaboration with the South African government agency in charge of STI policies.

Secondly, STI parks stimulate and manage the flow of knowledge and technology amongst universities, research and development (R&D) institutions, companies and markets; facilitate the creation and growth of innovation-based companies through incubation and spin-off processes; and provide other value-added services together with high-quality space and facilities (Link and Scott, 2007). As such, they are expected to produce mixed outcomes in terms of implementing their mandates. Notwithstanding, it is important to have a good understanding of the role of STI parks in economic development to provide a basis for establishing and implementing STI parks in African developing countries, particularly in Ghana.

Thirdly, STI parks are important intermediaries in any innovation ecosystem as they bring together various actors, typically government, industry, academic and research institutions, communities, entrepreneurs, financiers, other entrepreneurship support structures and markets (Thomas et al., 2020). As such, they promote a culture of innovation, supporting knowledge-intensive business development and thus positioning the region in which they are located for sustainable economic development and prosperity. For this to be realized, STI parks must recruit and co-locate into their precinct new and existing knowledge-driven companies and provide customized or flexible space, infrastructure and facilities to accommodate a myriad of knowledge-based businesses. In a region with few existing knowledge-based businesses, STI parks are important for fostering the development of start-ups with the potential to become high-growth businesses. Given the importance of knowledge and tech-based businesses for economic development, STI parks have an

STI parks are important intermediaries in any innovation ecosystem

important role in leveraging local knowledge resources to enhance the regional economy by facilitating knowledge and technology transfer from academia to industry and from elsewhere to the region (Sibanda, 2021). In co-locating knowledge, STI parks have the potential to play an active role in attracting investments into the region. Some of which may be either foreign direct investment, for instance when foreign companies setting up in a country, or investments to clusters in the STI parks arising from the growth of endo-genous research and skill (OECD, 2021).

The diverse roles and sets of activities that STI parks undertake make it evident that they can influence both the regional and national innovation ecosystems, including capacity-building, skills training, establishing and strengthening local and international partnerships and public-private sector engagements. Through diversification of the industrial base of the local economy, job creation, general and academic entrepreneurship development, skills development, income for the sponsoring university, business and personal incomes and taxes and social development, STI parks contribute to local, regional and national economic growth and development (Lyken-Segosebe et al., 2020)

STI parks evolved with national development needs

The African Union (AU) Agenda 2063 places great emphasis on countries in Africa investing in and using STI for inclusive and sustainable development; and transitioning the structure of many of the continent's economies from being resources-based to knowledge-intensive (AU Agenda 2063). Ghana's economy relies on an abundance of natural resources, including gold, oil, diamonds, manganese, limestone, bauxite, iron ore and forestry (Ministry of Land and Natural Resources 2021). While STI policies, as roadmaps to nurture technological development and innovation, need to be contextual to each country's development aspirations, level of development and economic and technological capabilities, STI parks have featured in many countries' policies as development instruments for promoting collaboration between universities, research institutions and industry, creating technology clusters and driving economic development (UNCTAD, 2015). Indeed, as shown by some countries' successes across the world, STI parks can be an effective way to stimulate a culture of innovation and to grow associated, knowledge-based businesses, particularly start-ups, that contribute to economic development, provided the right conditions are in place (Amoroso et al., 2019).

Evolution of STI Park Models

There are different types of STI parks (Gyurkovics et al., 2018; Sosnowska and Lobejko, 2017). First-generation STI parks are typically located in an area designated for this particular purpose in the immediate proximity of universities. Inspired by the success achieved by Stanford University in the USA at the birth of what was to become Silicon Valley, these tend to be managed exclusively by the university or through a university wholly owned enterprise. The focus is typically on the commercialization of university R&D, incubation and business services and accessing external sources of financing, including Venture Capital (Sosnowska and Lobejko, 2017). Second-generation parks are some sort of "extension" of first-generation ones but are not necessarily located in immediate proximity or operating under the exclusive supervision of a university. Most are run by private companies, although invariably, there is some academic and/or local government involvement in the governance structures. In addition to focusing on R&D commer-cialization, they focus on creating and supporting STI-oriented businesses, thus putting a stronger emphasis on start-ups. Third-generation parks are characterized by cooperation between the private sector or industry and academic and government players and function as aggregators of global and regional STI activities. In most cases, they offer a broad portfolio of STI-related services with a focus on developing their regions' entrepreneurial

culture through interactive, feedback-based innovation models. The governance and management are often based on long-term Public-Private Partnership principles. Day-to-day management is undertaken by a jointly owned business organization which is run by professionals or experts. Most STI parks in well-developed STI ecosystems tend to be third-generation STI parks. Fourth-generation parks are similar to third-generation ones except that these are typically in industrialized, knowledge-based economies with well-established entrepreneurship culture and a concentration of strong quadruple helix actors and as such, function as coordinators and/or aggregators of innovation activities (Sosnowska and Lobejko, 2017). Notwithstanding the generation of parks, their success depends on the level of technological development and industries in a country (Sibanda, 2021).

There are many variations in what a specific country terms a park and there can be hybrid structures. Hybrid structures can also evolve over time, for example, mixing features of an industrial park and an STI park. Hence the categorization of parks and incubators/accelerators and even industrial parks and SEZs, into neatly demarcated boxes is not always possible.

Ownership and governance models for STI parks vary, with most being publicly owned (including public universities), some being public-private partnerships and others owned by private firms or private universities (UNCTAD, 2015; Van Dinteren, 2021). The ownership and governance model depends on factors such as the context of the STI park establishment, funding sources and sustainability considerations. Notwithstanding the ownership or governance model, STI parks should strive to meet three broad goals (UNCTAD, 2015; UNIDO, 2021; Nakamine, 2022):

i) create an enabling environment that nurtures new and existing ventures,

ii) foster innovation and promote scientific capabilities and

iii) facilitate commercialization of local technologies and innovations that contribute to the economic development of the region where they are located.

Services Provided by STI Parks

STI parks provide hard and soft infrastructure services (Ng et al., 2021). The hard services refer to property-related infrastructure and include buildings, land for development, internet connectivity, security, restaurants, meeting rooms and security. The soft infrastructure relates to support given by a professional management team to tenant companies. This support can include mentorship, coaching, facilitating connections to stakeholders within the innovation ecosystem, creating conditions for firms to be near knowledge-based institutions and organizing networking activities. These activities can lead to knowledge- sharing and mutual learning.

For new and growing ventures, in addition to property-related services and a good location, access to land, land development and tenancy, other valuable benefits that they can derive from a park are through innovation and entrepreneurship programmes (UNIDO, 2021). To that end, STI parks either host third-party incubators or operate their own incubators (Sibanda, 2021). There is no one-size-fits-all approach regarding incubation in STI parks. Sufficient capacity and appropriate expertise and experience in supporting start-up businesses are critical, including business advisory services, mentorship, coaching, assistance with access to finance and markets, internet connectivity, space, facilities, meeting rooms, networking events, internationalization and marketing. Some of the support can be provided by a professional team of full-time employees of the park or, in some cases, external providers such as mentors (UNECA, 2023). As such, successful STI parks create an environment conducive to collaboration, networking and the growth of tenant companies.

STI parks provide hard and soft services

In addition to incubation services, successful STI parks run innovation and dedicated skills development programmes that support the commercialization of scientific and technological research into industrial and commercial success and develop talent to meet an industry's needs and in some cases, support entrepreneurs in their ventures (UNIDO, 2021).

STI Park Stakeholders

A STI park's stakeholders include government, private sector, academia and entrepreneurs

Within a triple helix model which includes government (local and national), private sector, academic and research institutions and entrepreneurs, STI parks can be effective intermediaries (Albahari et al., 2022) within an enabling STI policy environment which has knowledge-based industry or private sector. The government's role is important as it provides: a) clear policy direction and financial support for the developmental aspects of STI parks' mandates (UNCTAD, 2015; Van Dinteren, 2021); b) regulatory frameworks with favourable conditions under which STI parks can operate; c) fiscal incentives linked to domestic industry's strength or to catalyse certain industries and developments; d) making land available for a project; and e) ensuring there is basic horizontal and vertical infrastructure (UNIDO, 2021). In successful ecosystems, governments do not have undue influence or control of the park once a governance structure such as a Board of Directors has been put in place.

Successful STI parks require professional management

The private sector plays an important role in the formulation of an STI park's strategy, ensuring the relevance of the park to an industry's needs, bringing in skills and professionalism to the park management team, particularly where they are part of the ownership, ensuring that the park runs on a sustainable basis and being anchor tenants that can attract other businesses or firms to co-locate in the park (Wang, 2019).

Academic and research institutions provide R&D expertise, a skilled workforce that the industry concerned can employ, access to expensive research equipment, as well as knowledge and technologies for commercialization. When they are located within or proximal to a park, they strengthen the park's STI base (de Almeida Cadorin, 2021; Wang, 2019). Ideally, the location of an STI park should be in an area that is accessible and has a strong STI base (universities, research institutions and innovative firms) to build functional technology and innovation clusters (Wang, 2019; Van Dinteren, 2021).

STI Park Governance and Management

An appropriately constituted governance structure in the form of a statutory Board is important for providing oversight of the operations of an STI park. Such a board should comprise representatives of key stakeholders or regional or national innovation system actors. The government would generally appoint the Board or a majority of the Board members in cases where it is the owner or promoter of the park concerned and, in some cases, appoint the Chairperson. Separation of roles between the Board and management is important to ensure accountability, although the CEO may be a member of the Board as an executive director and, in some cases, an ex-officio member (Sibanda, 2021). In successful parks, the CEO is never the Chairperson of the Board, although they may chair the management executive committee. In some cases, there are one or more advisory boards that provide technical assistance to the management team in developing and implementing programmes. The statutory Board and, in some cases, the advisory Boards are responsible for the selection of anchor tenants at the park or may delegate this to management committees (Sosnowska and Lobejko, 2017).

Successful parks makeup a diverse, dynamic and business-focused professional management team that is well-networked in the innovation ecosystem and can build and manage relationships with different actors. In addition to technical or research and development expertise, the management team should also have expertise in coordination and communication among various stakeholders, capital management, infrastructure development, facilities management, business, marketing, new venture creation and growth, negotiation, events management, networking and communication (UNIDO, 2021). The management team usually has entrepreneurial skills and members with first-hand experience starting and running businesses, as this provides the park's incubation programmes with credibility. Given the dynamic environment in which STI parks operate, management must have the ability to adjust the park's strategy to an ever-changing environment (Wang, 2019). Where the management team comprises political appointees with no technical background, understanding of innovation, or previous experience operating within the innovation ecosystem, success becomes elusive (Sibanda, 2021). The CEO of an STI park is responsible for:

a) development of the park's strategy together with the Board and ensuring its approval;

b) implementation of the strategy and strategic plan;

c) day-to-day management of the park;

d) management of relationships with and expectations of the park's multi-stakeholders; and

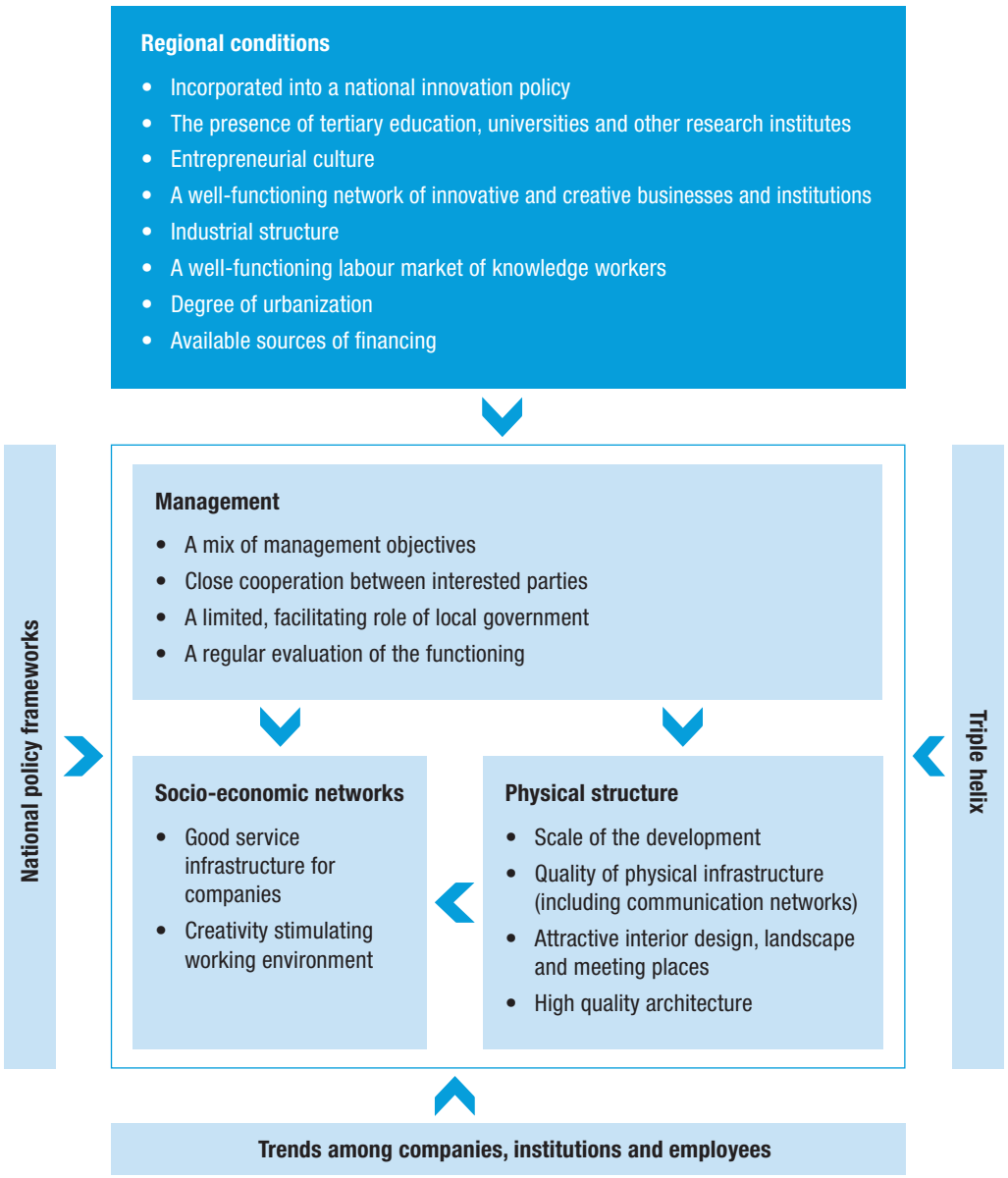
e) further development of the park, including scouting for resources.

Success Factors for STI Parks

STI parks are critical for regional economic development driven by scientific and technological advancements, innovation and cluster creation. Certain critical factors should be in place for their success. Van Dinteren (2021) summarizes these factors, reproduced in **Figure 1**. An enabling national policy framework is essential for the innovation ecosystem to have an effective triple helix of industry, higher education institutions and government. STI parks should also be part of national or regional innovation policies and operate in an environment where knowledge-generation institutions and private sector-led industries require a skilled workforce. Moreover, there should be a mix of funding sources, including grants, loans and equity. An STI park should have good management, be well-networked within the innovation ecosystem and have quality infrastructure to attract tenants.

Successful STI parks depend on certain critical factors

Figure 1
Success Factors for STI Parks



Source: adapted from Van Dinteren, 2021.

Indicators to measure STI parks' performance are implementation, outcome and impact

STI Parks Performance Indicators

There are a variety of matrices on which the performance of an STI park can be assessed. The real measure of success depends on the objectives and original purpose of the STI park. Table 1 provides a non-exhaustive set of matrices and indicators. It is important for an STI park to have a mix of the three types of indicators in its performance agreement with its shareholders, as some of these indicators are very operational (i.e. the implementation indicators), whereas others can be linked to the effectiveness of the initiatives implemented by the park (i.e. outcome indicators). The impact indicators measure the extent to which the STI park is achieving its purpose.

Table 1
Indicators for STI Park Performance

Implementation Indicators	Outcome Indicators	Impact Indicators
• Area of land developed, e.g. bulk infrastructure on the land. • Number of buildings or pace of construction of buildings. • Percentage of land developed. • Number of companies located in the park. • Percentage of occupancy of the buildings. • Number of companies graduating from the incubation programme. • Income from rent and services. • Type and range of typical services provided. • Number of international companies attracted to the park. • Number of graduates from skills development programmes. • Funding raised for start-ups in the incubation programme. • Alliances with industry or other companies in the value chain.	• Investment raised. • R&D investment undertaken by companies in the park. • Number of high-technology jobs created or enabled by innovation from companies in the park. • Number of local suppliers and workforce. • Number of products/services developed by tenants. • Number of technology transfer agreements. • Cooperation agreements established. • Number and type of intellectual property rights (in the form of applications for patents, trademarks, registered designs, or registered patents, trademarks or registered designs) from companies (primarily in incubation) and in the park.	• STI park's contribution to high-technology production. • Number and type of employment generated (e.g. number of qualified scientists and engineers employed). • Exports share related to the operation of the park. • Intra-industry structural change rate (share of high-tech activities within the region). • Salary increases of workforce in companies in the STI park compared to the national average.

Source: adapted from UNIDO, 2021.

III. STI Policies and STI Parks in Ghana

Ghana has put in place legislative, policy and institutional frameworks to boost the country's generation, exploitation, transfer and application of knowledge and technology. Recognizing that STI parks are useful instruments to achieve its STI policy objectives, Ghana has set up several STI parks.

Ghana is a coastal country in West Africa, neighbouring Côte d'Ivoire to its West, Burkina Faso to the North and Togo to the East. It is a member of the Economic Community of West African States (ECOWAS). Classified as a developing country, it has a population of 31 million people and a GDP of US$67.5 billion. The country's economy is dominated by services at 44.1 per cent, followed by industry at 31.52 per cent and agriculture at 18.78 per cent (Statista, 2024). The other sectors are extractives (coal and aluminium, with greater potential from liquefied natural gas production) and their manufacturing, contribute less to GDP compared to the agricultural sector. At the time of this paper, Ghana was undergoing external debt restructuring following the 2022 economic crisis. GDP growth is expected to remain subdued in 2024, because of high levels of inflation and fiscal tightening as part of the IMF bailout conditions (Economist Intelligence Unit, 2024). The economy is, however, projected to pick up sharply in 2027–28 on the back of increased exports of gold and oil resulting from new projects (*ibid*.).

STI Policy Framework

Over the past decade, the government of Ghana has launched four development plans to guide the growth and overall development of the country, namely, the Ghana Shared Growth and Development Agenda (GSGDA), 2010–2013 and the Ghana Shared Growth and Development Agenda (GSGDA) II, 2014–2017. These two plans were aimed at transforming the economy by "Advancing the Better Ghana Agenda." The other two development plans, Coordinated Programme (CP) for Economic and Social Development Policies, 2017–2024 and the Agenda for Jobs: Creating Prosperity and Equal Opportunity for All (First Step), 2018–2021, sought to create prosperity and equal opportunity for all through the "Agenda for Jobs" and leverage on STI "to stabilize the economy and place it on the path of strong, diversified and resilient growth" (UNESCO, 2022b). Within the medium framework span, this agenda was updated in 2022 and became "the National Medium Term Policy Development Framework (2022–2025) which is informed by the long-term national development policy framework, also known as Agenda 2057 or Ghana@100. Agenda 2057 envisions a democratic, inclusive, self-reliant developed country of Ghana by 2057.

Ghana's STI policies have evolved with the country's needs

The Ghana COVID-19 Alleviation and Revitalization of Enterprises Support programme was developed during the pandemic in 2020. It is part of the broader Covid-Africa Revitalization for Enterprises support programme, aimed at stabilizing the economy, revitalizing and transforming enterprises and safeguarding jobs. It promoted the growth of companies in producing medical protection equipment in STI parks, beginning a shift to STI parks in government programmes.

Some of the regulations and laws underpinning Ghana's STI policy environment, include the Technology Transfer Act and its Regulations; Ghana Investment Promotion Centre (GIPC) Act 865; Ghana's Intellectual Property regime; and National Research Fund Act that established the National Research Fund, the main source of funds for the development of Ghana's National Innovation Ecosystem (UNESCO, 2022b).

Ghana's STI strategies have been aligned with international, regional and national developmental agendas such as UN 2030 Agenda; AU Science, Technology and Innovation Strategy for Africa 2024; AU Agenda 2030; ECOWAS Policy on Science and Technology; and Ghana Shared Growth and Development Agenda 2014–2017. Over the years, Ghana's strategies for developing an STI system have evolved and have been supported by the National STI Policy Review of Ghana undertaken in 2009 jointly by UNCTAD, World Bank and Ghana Council for Scientific and Industrial Research-Science and Technology Policy Research Institute (CSIR-STEPRI); the National STI Outlook Reports; the National STI Baseline Survey Report 2016; establishment of the National STI Advisory Apex Body; the National Innovation/ Incubation Programme; establishment of the National Research Fund; the STI for SDGs Roadmap developed in 2022 in collaboration with UNESCO as a member of the UN Inter-agency Task Team (UN-IATT); the STI Policy 2017–2020 (hereinafter referred to as "2017 STI Policy"); and the STI Policy 2024–2030 (hereinafter referred to as "2024 STI Policy").

The 2017 STI Policy focused on harnessing Ghana's scientific and technological capacity to address a myriad of national priorities aimed at socio-economic development. This Policy emphasized the need to increase R&D investment to 1 per cent of GDP and highlighted the importance of strong partnerships between Ministry of Environment, Science, Technology, Innovation (MESTI) and other ministries as well as the scientific community. It also called for increasing the attention to STI among the population, strengthening STI capacity and encouraging the use and adoption of STI in all areas of the economy including driving industrialization. The 2017 STI Policy also identified STI park programmes and activities to be pursued by Ministry of Trade and Industry (MOTI). MOTI was asked to establish industrial parks, innovation centres and business incubators to foster linkages between the knowledge centres (i.e. research institutes and universities) and productive enterprises. In addition, the 2017 STI Policy advocated for the establishment of a Technology Commercialization Unit (TCU) under MESTI whose focus was to commercialize research outputs into new products, processes and services. TCU was also to be responsible for the establishment of incubation centres.

However, under the 2017 STI policy, incubation centres were the responsibility of MOTI (UNESCO, 2022b).

These overlapping responsibilities over incubation centres and several other challenges hindered the implementation of the 2017 STI Policy. They include:

a. limited funding for institutional programmes;

b. inadequate provisions for the development and management of frontier technologies;

c. ineffective coordination of the STI system and weak linkages between MESTI and other ministries, universities and research institutions;

d. low STI culture among the population; and

e. lack of alignment between the 2017 STI Policy and the STI for SDGs Roadmap.

The STI for SDGs Roadmap outlines an Ecosystem Development Plan that comprises the following:

- Improve or establish innovation systems and increase the opportunity for knowledge transfer between multiple actors;
- Deepen entrepreneurial culture and mindset;
- Foster collaboration between the private sector, universities and other research institutions;
- Introduce a Start-up Act to encourage and promote innovation and entrepreneurship; and
- Strengthen intellectual property laws to protect innovators and their innovations and encourage collaboration.

To address those challenges, Ghana updated its STI policy, which resulted in the 2024 STI Policy (Ghana MESTI, 2024). It has seven Key Objectives:

1. Increasing R&D investment to 1 per cent of GDP by 2030;
2. Facilitate industrialization by fostering innovation and technology adoption in key sectors;
3. Build human capacity to enhance STI capabilities;
4. Strengthen partnerships and collaboration amongst STI stakeholders;
5. Enhance sustainable environmental management practices that promote biodiversity restoration and conservation;
6. Foster adoption and application of frontier technologies; and
7. Integrate space science and technology into socio-economic sectors.

Ghana faced several challenges in implementing its STI policies

To achieve these Key Objectives, corresponding strategies are formulated. Key Objectives 1, 2 and 4 are most relevant for the development and roll-out of STI parks. Whereas Strategy 2.3 of Key Objective 2 (industrialization) elaborates on STI parks, the 2024 STI Policy has other strategies and activities relevant to STI parks, as summarized in **Table 2**. Apart from MESTI, there are other ministries in Ghana that are involved with entrepreneur-ship and STI parks, such as the MOTI and Ministry of Communications and Digitisation (MOCD).

STI Policy 2024–2030 now guides STI parks in Ghana

Table 2
Ghana 2024 STI Policy Key Objectives, Strategies and Activities Relevant for STI Parks

Key Objective	Strategies	Activities	Primary Responsibilities
1. Increase public and private investment in R&D to 1 per cent progressively by 0.2 per cent annually over the next 7 years to achieve GDP growth by 2030 through R&D driven innovation	1.1 Foster the commercialization of R&D outputs	1.1.1 Establish strategic technology-based centres of excellence	MESTI, MOTI, Association of Ghana Industries, Private Enterprise Federation (PEF), Ghana National Chamber of Commerce and Industry (GNCCI)
		1.2.1 Strengthen the operations of innovation hubs	MESTI, MOTI, AGI, PEF, GNCCI, CSIR
		1.3.1 Support private sector for the commercialization of local R&D technologies	MOTI, AGI, PEF, GNCCI
		1.4.1 Promotion of innovation culture in society	MESTI
		1.5.1 Encourage research institutions and universities to acquire intellectual property rights	MESTI, MOTI, Ministry of Tourism, Arts & Culture, Registrar General's Department, R&D institutions and universities
	1.6 Increase R&D investment in priority sectors such as agriculture, health and energy	1.6.1 Commercialize R&D into health care products and services	Ministry of Health, research & academic institutions, private sector
		1.6.2 Strengthen scientific networks and R&D for health innovations	Ministry of Health, research & academic institutions

Key Objective	Strategies	Activities	Primary Responsibilities
2.Facilitate **industrialization** of the country by fostering innovation and technology adoption in key sectors, aiming for an increase in value-added manufacturing and economic diversification while reconciling the social, economic and environmental pillars of sustainable development	2.1 Collaborate with MOTI to effectively implement the current industrial plan (Ghana Export Development Strategy), ensuring alignment between STI initiatives and industrial development goals especially in agriculture, health and energy	2.1.1 Conduct feasibility studies to establish strategic technologies and innovation centres	MESTI, MOTI, Ministry of Finance (MoF), CSIR
		2.1.2 Establish strategic technologies and innovation centres in selected priority areas such as agro-processing, oil and gas, waste management, automotive sector and healthcare	MESTI, MOTI, AGI, PEF, GNCCI, CSIR
	2.2 Strengthen the linkage between the research system and industry, specifically focusing on the adoption of clean technologies and frontier technologies to improve industrial sustainability and competitiveness	2.2.1 Institute the establishment of regional centres of excellence and facilitate strong linkage to Ghana Innovation and Research Commercialization (GIRC) Centre	MESTI, MOTI
	2.3 Establish and strengthen technology incubators and innovation hubs to provide start-ups and micro-, small and medium- sized enterprises (MSMEs) with the necessary infrastructure, mentorship and access to funding to stimulate innovation, growth and job creation	2.3.1 Identify and prioritize strategic areas for PPP promotion	MESTI, MOTI, Ghana Export-Import (GEXIM) Bank, GIPC, CSIR
		2.3.2 Develop incentives to support PPP ventures	MESTI, MOTI, GEXIM Bank, GIPC, CSIR, AGI, Ghana Enterprises Agency
		2.3.3 Profile all technologies and innovative products and services from all STI institutions in the country	MESTI, MOTI, GEXIM Bank, GIPC, CSIR, AGI, Ghana Enterprises Agency
		2.3.4 Promote young entrepreneurship in the development of technologies locally	MESTI, MOTI, GEXIM Bank, GIPC, CSIR, AGI, Ghana Enterprises Agency
		2.3.5 Conduct STI needs assessment of MSMEs	MESTI, MOTI, GEXIM Bank, GIPC, CSIR, AGI, Ghana Enterprises Agency
		2.3.6 Facilitate sensitization workshops and seminars on technology needs/ requirements for business start-up and growth of MSMEs	MESTI, MOTI, CSIR

Key Objective	Strategies	Activities	Primary Responsibilities
3. Strengthen partnerships among various STI stakeholders for sustainable development	3.1 Improve inclusion and build more linkages across the national system of innovation	3.1.1 Target technology development and deployment to support the private sector	MESTI, Ministry of Education, MOTI, CSIR, Ghana Atomic Energy Commission (GAEC), Ghana Regional Appropriate Technology Industrial Service (GRATIS), Commission for Technical and Vocational Education and Training
	4.1 Integrate innovation strategies into local and regional economic development planning for growth, productivity and competitiveness	4.1.1 Develop a framework for integrating the STI policy strategies for innovation with local and regional development plans	MESTI, Ministry of Local Government and Rural Development, MoF, CSIR-STEPRI

Source: adapted from Ghana MESTI, 2024.

Notably, whereas the 2017 STI Policy proposed a TCU, the 2024 STI Policy does not take this concept further. Instead, as part of the integration of various disparate policy documents under the MESTI, the 2024 STI Policy highlights the 2022 Master Plan for the GIRC Centre and its operationalization. However, none of the Key Objectives, strategies and activities provide specific further details on the GIRC Centre, which appears to have a broader mandate than that of the TCU. This includes funding and development of the national innovation ecosystem based on triple-helix partnerships and promotion of commercialization of research output and innovation. There is no specific pronouncements or indications of how the GIRC Centre and STI parks would work together.

Government Agencies Involved in STI

MESTI is responsible for the development and implementation of STI policies, plans and programmes in the country. It oversees several R&D agencies. The MESTI mandate on STI is to promote adoption and application of science and technological innovations. Whereas Ministry of Education is responsible for all levels of education including tertiary education through the Ghana Tertiary Education Commission responsible for the advancement and application of knowledge through teaching, scholarly research and collaboration with industry and the public sector, MESTI is responsible for all STI related aspects of research at higher education institutions. MESTI's STI policy direction is derived from the Presidential Advisory Council on Science and Technology and Innovation which ensures that the government prioritizes STI and advises on STI issues to inform the development of policy and decision-making. This ensures that STI remains Ghana's priority for socio-economic development.

MESTI oversees several agencies that include the Council for Scientific and Industrial Research (CSIR) with 13 institutes having different focus areas, Ghana Atomic Energy Commission (GAEC), Environmental Protection Agency, Land Use and Spatial Planning Authority, National Biosafety Authority and Nuclear Regulatory Authority. These agencies are regulated by the Council for Scientific and Industrial Research Act 1996, the Cocoa Research Institute Act, the Ghana Atomic Energy Commission Act 2000 and Public University Acts.

Other relevant agencies in Ghana's STI ecosystem include the National Entrepreneurship and Innovation Programme (NEIP), the Ministry of Business Development, MOCD and MOTI.

Research Institutions and Research Outputs

The 2017 STI Policy provides a governance structure for STI which includes institutions for the management and coordination of research. The CSIR is charged with the coordination and implementation of government policies on R&D and assists in policy development (MESTI, 2017). The CSIR also plays a role in the commercialization and dissemination of research outputs and technologies, its own and that of third parties (Boateng, 2024). MESTI oversees and coordinates the activities and programmes of the CSIR and its 13 research institutes. The GAEC is also a major public research institution in Ghana and comprises six Atomic and Nuclear Research Institutes. Other STI Institutions include the Cocoa Research Institute of Ghana, Noguchi Memorial Institute for Medical Research, Centre for Scientific Research in Plants Medicine, GRATIS Foundation, Ghana Standards Authority and the Food and Drugs Authority (Fosci et al., 2019; UNESCO, 2022b).

Ghana has several academic or higher education institutions. This includes 15 public universities, 8 technical universities, 2 polytechnical universities and 71 private universities which run various science, technology, engineering and mathematics programmes and are accredited institutions. Out of the 71 private universities, only 6 run programmes related to science, technology, engineering and mathematics. There has been a determined focus on upgrading technological capability through support to universities, specialized R&D institutes and private businesses with a view to driving the Ghana Beyond Aid Agenda. Accordingly, a flagship system of Ghana's Centres of Excellence has been established to network all academic institutions in support of research and innovation. These centres include:

1) University of Ghana: West Africa Genetic Medicine Centre;
2) Kwame Nkrumah University of Science and Technology: Regional Transport Research and Education Centre, Kumasi;
3) Kwame Nkrumah University of Science and Technology: Engineering Education Project;
4) University of Cape Coast: Africa Centre for Water, Irrigation and Sustainable Agriculture; and
5) University of Energy and Natural Resources: Regional Centre for Energy and Environmental Sustainability (UNESCO, 2022b).

Ghana Centres of Excellence network all academic institutions

Publishing 104 publications per million people, with a lower citation impact compared to other Sub-Saharan countries, Ghana also struggles with the commercialization of its research or the diffusion of research outcomes, which is not surprising given the limited intellectual property awareness across research organizations and the low number of patent filings (Fosci et al., 2019).

R&D Funding System

As part of the Coordinated Programme of Economic and Social Development Policies (2017–2024) and comprehensive policy framework for STI developed under the auspices of the MESTI, the government seeks to leverage STI for development by increasing the public funding for R&D from 0.38 per cent in 2010–2020 (World Bank, 2024) to at least 1 per cent of the GDP. This is in line with Key Objective 1 of the 2024 STI Policy. In absolute terms, the country spent US$700 million on R&D in 2022 (Statista, 2024). Government accounts for 68.3 per cent of the general expenditure of R&D, with higher education, business and domestic private non-profit sources

combined contributing only 0.5 per cent of the general expenditure of R&D. The balance is funded by foreign organizations and donors (Fosci et al., 2019).

The proportion of Ghana's budget allocated to STI and R&D has consistently fallen below the 1 per cent target, fluctuating between 0.3 per cent and 0.5 per cent (MESTI, 2021). The low R&D investment not only affects R&D activities in higher education institutions but also affects the ability to support and fund start-ups in incubation hubs (UNESCO, 2022b). The government has funded 70 per cent of STI in Ghana over the past decade. Grants and donations representing 20 per cent of R&D institutions' annual budgets while other institutions utilize their internally generated revenues, representing about 10–30 per cent of their annual budgets, to fund their R&D activities, programmes and projects (Quaye et al., 2019, 2019). Higher education institutions have always relied heavily on government funding, which is inadequate. Much of the government funding to the institutions is in the form of Research and Book Allowance scheme, which is not linked to research production (Fosci et al., 2019).

Research funding is expected to increase

Ghana aims to increase its general expenditure on R&D through the National Research Fund Act, which was passed in 2021 and encourages the private sector to support R&D activities by instituting attractive tax incentives for contributors to R&D activities, without eroding the national tax base (MESTI, 2017; UNESCO, 2022b; 2024 STI Policy). Section 2 of the Ghana National Research Fund Act states that the fund will be applied to, *inter alia*, promotion and support of STI research, technology transfer and innovation and specific research into science and application of biotechnology, genetics and genomics. The sources of the National Research Fund include an amount not exceeding 0.5 per cent of the annual national revenue, grants, donations, gifts, voluntary contributions, accrual from investments made by the National Research Fund Board and returns from implementation. At the time of this paper, the National Research Fund has not been operationalized. Once operational, it will contribute to a pipeline of R&D outputs that can be commercialized through STI parks.

Gender Dimensions of the STI Ecosystem

Ghana has been implementing a National Gender Policy since 2015 through the Ministry of Gender, Children and Social Protection. This policy requires state agencies and organizations to mainstream gender into their policies, plans and programmes. The policy was updated in 2023 as the revised National Gender Policy (2023-2032), awaiting Cabinet approval (Ghana MGCSP, 2024). In accordance with the current National Gender Policy, a Desk Officer for Gender was designated in MESTI. In addition, the Granting Secretariat of the Ghana Science Granting Council within MESTI has a lead expert on Gender, Equality and Inclusivity which is a key theme for the Council that manages grants to support applied research projects in Ghana.

Despite the efforts made by the government and other stakeholders, gender disparity persists in Ghana's STI ecosystem. One example concerns human resource development in the STI field, particularly the share of females studying science and engineering in higher education institutions. While gender parity was impressive in terms of enrollment in tertiary education with 47.3% being females and 52.7% being males for the year 2020/2021, more males compared to females were studying science and engineering programmes in the tertiary universities, standing at 61 per cent and 39 per cent respectively (UNESCO 2022a). The reason for the lower female participation rate may be that at the upper secondary schools there is only 19.76 per cent female participation compared to 80.24 per cent male in science, technology and math subjects (UNECA, 2024).

Another example is the low rate of female participation in the technology sector with

only 13 per cent technology entrepreneurs being women (Ghana News Agency, 2024). Globally, 23 per cent of women with science, technology, engineering and mathematics majors take up technology roles compared with 44 per cent of men. The low retention rate in the technology sector further contributes to the disparity. Over half of women in technology leave the sector by the midpoint of their career—a rate more than double that of men (McKinsey & Company, 2023).

Research in Ghana shows that some of the assumptions surrounding technology also contribute to the gender disparity. Some are stereotyping that technology is hard and the other assumptions are on women entrepreneurs in technology, for example expecting women to stay at home and take care of children. The same research also suggests that with an early technology education and mentorship, more women will be able to join the tech sector (Naisubi, 2020). Hence raising females' awareness in technology, developing their technology skills and encouraging them to join in the technology sector may change the mindset of females who think technology is hard. Availability of resources like training, funding and networks will encourage and increase women participation in technology entrepreneurship.

The Ghana government is increasing its efforts to boost the participation of females in technology. The updated National Gender Policy will incorporate the promotion of females as innovators and entrepreneurs (Ghana News Agency, 2023). The MOCD has launched a "Girls in ICT Trust" initiative that will provide resources, training and support aimed at empowering young women and girls in ICT (Ghana MOCD, 2024).

STI Parks and Similar Organizations

As early as in 2008, Ghana announced its intention to set up science and technology parks with a focus on product innovation, advancement and manufacturing with support from universities, research institutions and the market (Markwei, 2008). Since then, there has been noticeable growth in the number of STI support organizations in Ghana, which includes models such as incubator-accelerator, incubator-workspace, incubator-funder and solely workspace-type organizations (British Council, 2016). According to the Situational Analysis of STI for SDGs Report of 2020, there are 44 organizational support structures comprising innovation hubs and incubators listed under the NEIP (UNESCO, 2022b, Annex A). The target sectors of STI parks include agribusiness, agro-processing, ICT, sports, tourism, creative arts, health, waste management, logistics, manufacturing and industrial processing. These target sectors align with the NEIP (UNESCO, 2022b). Of the 44 incubators and innovation hubs in Ghana, at least 50 per cent (23) are in its capital city, Accra (UNESCO, 2022b; Walls, 2022).

STI parks in Ghana targeted at various sectors

Access to finance is one of the major challenges for entrepreneurs in Ghana. For example, in 2022 the Sunyani Technical University called for an increase in the Ghana Education Trust annual allocation to the University for the completion of its science park project which began almost two decades ago. The 4-storey science park project which began in 2008 has only had the ground floor completed due to inadequate funding (Drizasah, 2022).

Although incubators are cited as a potential funding source, entrepreneurs still struggle to access financing or funding for incubators (Van de Biest and Wyss, 2019). Accra scores a Start-up Friendliness Index of 24.76 out of 100, suggesting the city's potential for entrepreneurship in terms of the "*Start-up Scene*" domain. This domain comprises two subdomains:

1) Hubs, which includes accelerators, incubators, co-working spaces and technology parks; and

2) Activeness, which involves start-up events as well as the total number of start-ups. Incubators in Accra are reported to be the leading contributors to the Hubs subdomain

and to the overall "*Start-up Scene*" domain. The Activeness subdomain is the majority contributor to the "*Start-up Scene*" domain (*ibid*.). Meltwater Entrepreneurial School of Technology (MEST) Africa is one of the incubators located in Accra which is ranked in the top 22 Ghana's start-up incubator list (Walls, 2022) and in Africa's Top 21 Start-up Accelerators (Goncalves, 2023). Leveraging its partnerships with the telecommunications, banking and insurance sectors, MEST has propelled start-ups into new international and domestic markets (Afric'innov, 2020). It has trained and incubated over 1000 entrepreneurs, funded at least 80 businesses, graduated 52 Venture Capital fundable start-ups, resulting in the creation of over 750 jobs from successful start-ups (MEST, 2024). Other incubators and innovation hubs located in Accra include, amongst others, Eqwip Hubs, Ghana Innovation Hub, the Impact Hub, Kosmos Innovation Centre and iSpace Foundation. There is also the Ghana Innovation Hub, which is discussed below.

There are a total of six incubators and hubs in the Ashanti region, namely, Kumasi Hive, HapaSpace, Kumasi Incubator, NBU (SOS) Hub and CIS. The remaining 14 are spread across other regions in Ghana, including Brong Ahafo, Cape Coast, Central, Oti, Volta, Eastern, Northern and Savannah regions of Ghana.

Incubators in Ghana are generally on-site management focused on helping start-ups develop, market and manage resources tailored to their needs. Some provide access to workspaces, basic office services, equipment, technology support services and limited access to funding. These incubators also train and equip entrepreneurs with the necessary skills, networks and expertise to create sustainable businesses. The result of incubators and innovation hubs in Ghana is evident in the number of companies created, which is mostly published on some of the incubators' websites. The number of start-up companies produced by various incubators has increased over the years (Afric'innov, 2020; Kuuire, 2023). Ghana has also benefited from start-ups graduating from incubators within the energy sector, climate innovation and agriculture (Yawson, 2002), which is indicative of the STI parks' impact and outreach. The result of incubators in Ghana can also be measured by the number of entrepreneurs incubated, graduated and jobs generated by the successful start-ups. These numbers are reported as increasing by incubators such as MEST and the like. Whether or not an incubator or innovation hub addresses a particular disadvantaged group may be indicative of its overall effectiveness (Yawson, 2002). Ispace Foundation and Sun City Hub are some of those committed to empowering women entrepreneurs who are generally disadvantaged regarding access to education and training, employment and income (Apusigah, 2005).

The number of incubated start-ups and entrepreneurs has increased

However, there are several structural barriers for entrepreneurs, such as limited access to funding, inadequate data communications infrastructure and lack of collaboration among start-ups (Turolla et al., 2022). Despite the challenges, over the past four years there has been a 56 per cent compounded annual growth rate in funding which affirms Ghana's position as an attractive start-up hub. There are over 500 active start-ups countrywide. The total start-up funding raised between 2019-2022 is over US$542 million, with fintech and healthtech being the most funded industries (Turolla et al., 2022).

Incubators in Higher Education

There are several incubators within the universities across Ghana. The Koforidua Technical University has a Centre of Entrepreneurship and Innovation Development which equips students with the entrepreneurial skills essential for establishing their own businesses. The Centre of Business Development at the Kwame Nkrumah University of Science and Technology promotes spin-offs at departmental levels. The University of Cape Coast Business Incubator supports student entrepreneurship and small enterprise development in Ghana (UNESCO, 2022b).

Launched in 2005, the Ghana Climate Innovation Center (GCIC) under the World Bank Group's Climate Technology Program, is run by a consortium, including Ashesi University College of Ghana. The GCIC is an incubator promoting business development for the green economy, seeking to identify and support entrepreneurs as they transfer their inventions to address climate challenges in Ghana. The incubator's thematic focus areas include solar energy, energy efficiency, waste management, climate-smart agriculture and water purification. GCIC offers a complete range of services to incubate, such as training, market development, proto-type testing and seed funding (Afric'innov, 2020). In 2017, GCIC admitted the first cohort of 11 incubatees from a total of 72 applicants who responded to the Expression of Interest advertised by the CIC (GCIC, 2017). To date, the GCIC has incubated 83 entrepreneurs. In 2019, GCIC reported to have graduated 20 entrepreneurs, creating 127 direct jobs, 57 of which are women-led (GCIC, 2019).

In February 2023, the University of Ghana Business School, in collaboration with Agricultural Manufacturing Group Limited, launched the Innovation and Incubation Hub named as "UGBS-Nest". It aims to promote student innovations and technology-based entrepreneurship by providing support and training for students and innovators (Ofori, 2023). The project is still at a nascent stage.

Others

Under the involvement of MESTI, MOTI and MOCD, several STI parks have been established.

- **CSIR-Industrial Innovation Research (IIR) Innovation Hub:** CSIR supports, through its IIR unit, innovators by providing space, access to broadband connectivity, business mentoring services and access to technologies across other CSIR units. This service is provided for free and the space is at a nominal fee. It is envisaged that once the innovator graduates and the business concerned requires bigger space, it is moved to a commercial building, where a commercial rental fee is paid and management contract with the CSIR-IIR is established to manage the commercial activities. The CSIR-IIR industrial innovation hub was initiated in 2019 and has made success with the first company, which is now selling its products and services regionally. To date, IRR has provided access to research, product development, quality assurance and needs-based capacity-building training. The innovation hub is in line with the CSIR's mandate to coordinate science and research in Ghana and conduct research, commercialize products and knowledge transfer. The companies in the Hub pay nominal (i.e. non-commercial) fees for the space and the support provided by the Hub.

  The CSIR research output is transferred to communities as a public good aimed at creating wealth for the country. Preference is given to those companies that work in areas closely aligned with what CSIR does, or innovators that want to commercialize CSIR research, hence creating a channel for commercialization of CSIR technologies. In so doing, the relevant CSIR institute will have commercial interest in return for granting a licence to companies or innovators. The pipeline is currently being sourced by word of mouth, as the Innovation Hub has been run as a pilot project, funded only by the CSIR-IIR. The current focus is on Small and Medium-sized Enterprises (SMEs) as they struggle with research budgets.

  Intellectual property ownership is governed by the CSIR policy. As such, intellectual property is owned by the CSIR for research initiated and funded by CSIR. For research initiated and funded by a company, it is owned by the company. The positioning of the innovation hub under IIR is apt given the unit's positioning between research and industry. The IIR Innovation Hub is seen as at the forefront of industrial parks and STI park development in Ghana.

- **Ghana Innovation Hub (GIH):** GIH was established in 2019 as part of the World Bank project to provide space and capacity-building to entrepreneurs and run less costly innovative programmes for businesses in Ghana. It is run as a non-registered project and was jointly set up by Management for Development Foundation (MDF) – Africa, BlueSPACE Africa Technologies and Ghana Communication University. While BlueSPACE Africa Technologies is a business technology integration company building backbone systems and data infrastructure that enables secure and efficient business operations, MDF was created in 1984 in the Netherlands, having a team of professionals with complementary expertise in providing learning trajectories, advisory guidance, facilitation, evaluations, enterprise development and partnership services in Africa, Asia and Europe. The project is one of the MOCD programmes and used to be under the E-Transform Programme. Now it falls under the new Ghana Digital Acceleration Programme, with a Board comprising two people selected from the MOCD and three other external people selected to run it. The three external people are from the MDF-Africa acting as the Board Director, Blue Space and the Ghana Communication University. Apart from the five-member Board, the World Bank and the MOCD set up a committee to supervise the activities of the Hub.

  GIH has been funded by the World Bank and the Ghana Government through MOCD. However, some of its programmes are funded by different partners such as the Dutch Export Academy, Japanese International Cooperation Agency (JICA) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ or in English, German Development Cooperation), among others. 60 per cent of funding comes from the Government of Ghana and 40 per cent from other partners. As of 2024, the total annual budget for GIH was US$2.1 million (Yeboah, 2024). GIH's twenty staff members is comprised of the Hub Manager, seven administrative and support staff and twelve training consultants. It has no land, nor does it own its building. It is hosted at a government facility at Accra Digital Centre where they are provided with rooms for office spaces, conferences and co-working spaces for entrepreneurs to have their meetings. GIH does not have test laboratories of its own either and it relies on partnerships. It is generally sector-neutral, with its focus being on assisting innovators of all forms. It has supported, among others, entrepreneurs in ICT, biotechnology, manufacturing, green Economy, agri-business, horticulture, technology base, textiles, food and value chain sectors. Most of the entrepreneurs supported are in the 18–45 age range.

  One of GIH's flagship programmes is the Dutch-funded Orange Corners Programme which has been run for the past 5 years. It is an accelerator programme where participants should have already established their businesses for at least one year and have attained measurable revenues. The last graduation was conducted in February 2024. The focus is on the formalization of entrepreneurs in the 18–35 age range. The programme assists them in certification, registration and tax registration and payment processes, as part of its activities to help them become investment-ready. Through the Orange Corners Programme, at least 500 people have been trained and about 200 people's funding requests have been processed. A dedicated room is reserved under this programme for participants to access free of charge at any time. GIH also runs several other programmes. One of them is the AFORD Programme which links people in the diaspora who wish to

relocate to Ghana or set up businesses in Ghana to SMEs . Additionally, SMEs in Ghana that want to export their products are also connected with individuals abroad. There is also a separate office space for the AFORD Programme. Another one is the JICA Programme, which is an ideation programme funded by JICA and prepares people with ideas to pitch for funds. Finally, GIH also runs the Dutch Export Academy Programme for operational businesses that wish to export their products or services (Yeboah, 2024).

- **Kosmos Innovation Centre (KIC):** KIC was established by Kosmos Energy, an Oil and Gas company that, as part of its corporate social responsibility, discovered gas in Ghana in 2007. The agricultural sector was identified by the government of Ghana as lacking support, with a shortage of youth and underutilization of technology.. Initiated in 2016, it runs different programmes depending on market needs. It organizes Agritech challenges, that bring young people together to go through ideation and basic business principles in teams, then pitching to judges from KIC, who help them refine their products and bring them to the market. To date, it has supported 41 businesses, 34 of which are still actively operational. Headquarted in Accra, KIC operates country-wide and works collaboratively with at least 10 universities and faculty advisors. These universities are KIC's incubation hubs in the region.

  KIC provides milestone-based seed funding grants for businesses in their incubation programme. In addition to start-ups, it also supports, through its Business Booster Programme,agri-businesses that have been in operation for three years. Thisprovides business diagnostics to determine how they can scale up, as well as an accelerator programme with aftercare services. KIC has established an Alumni network or fellowship programme for those who have got its support to be further supported. This programme also supports fledgling businesses in incubation. Young Agripreneurs Forum clubs have been established on university campuses to create awareness of opportunities in agriculture. KIC also runs a School Farm competition, targeting junior and senior school students, training young people in areas of backyard farming, basic agricultural practices and cultivation of 2–3 acres of fields to produce crops that can be sold. The Centre works closely with the government and has a MOU with CSIR whose institutes support the Agri entrepreneurs that KIC works within hardware development and access to technical capacity to solve challenges. In 2020 KIC signed a partnership with Mastercard Foundation for capacity development (KIC, 2024).
- **Design Technology Institute (DTI):** The DTI is a private vocational training college that has been accredited by the Commission for technical and vocational education and training (TVET) in Ghana. It has been operating since September 2019. During the five years of operation, it has increased its annual student intake from 32 to 237 students. DTI runs a dual TVET system that focuses on equipping youth with various technical, engineering, innovation and creative skills, to develop innovative solutions for challenges facing their communities, Ghana and the African continent at large. Its prototype centre provides youth with training and business skills for careers in precision welding and fabrication; innovative design; software engineering and 4th Industrial Revolution; and creative industries including photography, sound, videography and multimedia. Its programmes are 18 months long, of which six months are industry placement. The institute has a 75 per cent market uptake of its students. From an innovation and entrepre-

neurship angle, it runs a challenge programme under which students come up with solutions to real problems and they are provided with incubation services. In the past three years, with the support of the Masterclass Foundation, the institute has been working with artisans in various regions in Ghana to set up businesses and provides a week long precision quality curriculum. The DTI places a significant focus on inclusivity and strives to ensure at least 30 per cent women participation in its programmes. As of January 2024, DTI was engaged in the design of an innovation hub with the support of the AfCFTA Secretariat and the Mastercard Foundation (DTI, 2024).

- **Kantanka Group:** The Kantanka Group is a private multidisciplinary integrated group of companies with a focus on innovation and entrepreneurship across a number of industries. The group offers world-class services in technology, security, food sufficiency, construction engineering, contemporary herbal medicinal research and safe transportation systems. It works closely with universities and offers university students practical exposure and vocational training whilst encouraging them to think innovatively and be entrepreneurial. Through its innovative and entrepreneurial approach to training, product development and manufacturing, it is a critical private sector group for innovation in Ghana. Its privately funded campus of about two hours' drive outside Accra houses the Kantanka Herbal Pharmaceuticals and Research Centre and a new pharmaceutical manufacturing plant. This campus operates as an innovation hub for the group (Kantanka, 2024).
- **Ghana ICT Hub:** There has been increased attention to ICT hubs, with the most recent one being the commitment in 2023 by a telecommunications group named MTN to build the Ghana ICT Hub. It will be a physical infrastructure and provides 4,000m2 of space with ancillary facilities and unique features. Projected to be completed 18 months from the commencement of construction, the Ghana ICT Hub will provide office and meeting facilities to more than 100 tech companies that are anticipated to be incubated; create an ICT ecosystem in health, agriculture and education sectors; train youth in ICT and digital skills; and generate more than 100,000 jobs within the first three years (B&FT Online, 2023).

IV. Challenges for STI Park Development in Ghana

Ghana faces multiple challenges in maintaining a well-functioning ecosystem for STI parks and in effective operation and management of STI parks that are crucial to the development of STI parks in Ghana.

Ghana needs to address pressing challenges in leveraging STI parks as an effective tool to harness the potential of STI for the country's sustainable development, including industrial and agricultural development. These challenges affect the ecosystem for STI parks and their operation and management, including:

a. implementation of the updated STI policy is slow and hampered by limited public awareness and inadequate funding;

b. a disconnect between R&D efforts and the commercialization potential within STI parks, compounded by weak coordination among government ministries and a lack of robust public-private partnerships; and

c. insufficient infrastructure and support mechanisms to respond to the growing interest in STI parks from higher education institutions and the private sector, with many incubators lacking the necessary resources and expertise to effectively nurture innovation and entrepreneurship.

STI Policy Environment and Ecosystem

i) Although the Ghanaian STI policy environment is well developed, implementation has been slow and, in some cases, been impacted by policy uncertainty, as has been the case with the 2017 and 2024 STI Policies. The latter has taken some time to be approved by the Cabinet. There is also low awareness on STI policy and limited information flow.

ii) An effective STI policy should emphasize three areas:

   a. strengthening the 'supply-side' for STI, for example by promoting science and technology-based education, setting up R&D laboratories, funding R&D in universities, creating science and technology-based large public enterprises and improving intellectual property rights;

   b. supporting entrepreneurship at large, for example, by implementing policies and programmes that finance small and medium business or start-ups, easing regulatory barriers to start or end a business; and

c. strengthening the links between STI, entrepreneurs, start-ups and markets, for example, through setting up incubators and other intermediaries like science parks, technology transfer centres that support technology transfer especially for technologies related to societal goods that would be unable to advance to market in the absence of different types of public support (Surana et al., 2020). It is evident that successful STI parks will require all the three elements to be in place. Whereas Ghana's STI policy appears to have addressed two of these areas, a lot remains to be done with respect to a), i.e. the supply side for STI, to create a dynamic STI ecosystem.

iii) The 2024 STI Policy has clear pronouncements on the support for STI parks and provides several specific interventions in that respect. However, there is a lack of clarity on the resources that would be allocated to an intervention like this.

iv) Coordination could be a systemic challenge given the cross-cutting nature of innovation and the fact that some of the STI parks initiatives fall outside the control of the MESTI but other Ministries.

v) There are significant STI parks activities being undertaken by the private sector or non-governmental organizations. Some of these have little or no support from government, yet they contribute towards realization of the ideals of the STI policy.

vi) Despite a clear STI policy environment, some of the challenges appear to be:

a. Low R&D funding, with the funding that is provided particularly in higher education institutes (HEIs) being inadequate to carry out meaningful R&D that could result in outcomes that can be commercialized in the STI parks;

b. Lack of coordination between the activities of the R&D generation institutions (i.e. HIEs and research institutes) and the STI parks which affects commercialization of R&D outputs; and

c. No funding for the establishment and operations of the STI parks. This is somehow improved in the case where there is private sector involvement – but even in these cases, government seems to not provide dedicated co-financing to ensure the success of the STI parks.

Operation and Management of STI Parks

i) Despite a fairly large number of incubators in Ghana, STI parks remain a nascent feature of the STI ecosystem, with no large infrastructure based STI parks.

ii) HEIs are starting to take an active interest in STI parks, as evident from the incubators at Ashesi University where the Ashesi Venture Incubator (AVI) offers a comprehensive 12-month programme designed to help build, launch and scale high-potential businesses (Ashesi University, 2024), University of Ghana Legon Campus (Ofori, 2023) and the DTI. It is important however to manage the establishment of STI parks at HEIs to align with R&D intensity and outputs.

iii) Most STI parks provide typical interventions such as mentoring and coaching, hotdesking or office space, business support and access to networks. However, access to funding and market access are still a challenge, given lack of public sector funding which is typical in countries with successful STI parks. Public funding is important to mitigate innovation risk and crowd in private sector funding.

iv) There is consensus amongst stakeholders interviewed for the purpose of preparing this report that not all incubators are providing value. Some of the reasons identified include:

   a. Most incubators are incapacitated;

   b. Some just have space and lack technical expertise for product development, prototyping and business support;

   c. There is a need for extreme technical support for some of the solutions emerging from entrepreneurs;

   d. Most incubators lack proper funding for their activities. There is some funding from NEIP and the Ghana Enterprises Agency. However, this is not adequate to finance the operations of the STI parks;

   e. There is a lack of entrepreneurial talent as entrepreneurship is not being promoted in the education system but is seen as a pathway for survival. There is a need for intentionality regarding entrepreneurship;

   f. There is still a shortage of strong pipeline to be supported by the STI parks, though progress has been seen as demonstrated by a growing number and diversity of "use cases" and emerging entrepreneurship hotspots in the country, such as Accra, Kumasi, Takoradi, Tamale, Ho and Koforidua; and

   g. Duplication of efforts should be addressed. Lots of programming target the small pool of entrepreneurs. This has resulted in serial incubation and acceleration, i.e. entrepreneurs hopping from one programme to another.

v) Partnership between public and private sector in respect of STI parks is weak. There doesn't appear to be a business model of what kind of partnership would work and how STI parks should be run. Private sector partners in Ghana expressed a view that the government and agencies should do more facilitating than leading and that the private sector should lead and have agreed performance outcomes with the government. In this respect, there should be a dedicated management team for the development and management of STI parks.

vi) Given the small scale of the STI parks in Ghana, the current governance models are probably appropriate. However, where there are Boards, most do not have the mix of public-private sector expertise on their Boards. This has been seen as critical in most successful STI park ecosystems elsewhere.

V.
Conclusions and Recommendations

The number of STI parks has been growing in Ghana with increasing recognition of their potential in generating, exploiting, transferring and applying knowledge and technology, hence leveraging STI for sustainable development. However, Ghana's STI parks face significant challenges that impede their effectiveness and growth. Recommendations are proposed in four areas concerning STI policy implementation, institutional strengthening, promoting inclusiveness and capacity development.

Ghana's 2024 STI Policy contains several provisions on STI parks and provides an enabling environment for the development of STI parks in the country. Driven by MESTI, Ghana's STI ecosystem shows some promise, with significant entrepreneurial initiatives at HEIs, public and private sectors. At the core of government's STI park initiatives is the CSIR-IIR which appears to have good relationships with industry.

Notwithstanding these initiatives, there is an opportunity for strengthening coordination, as well as more government involvement in aligning these initiatives to the country's strategic development priorities.

While STI parks are an emerging developmental instrument in Ghana, significant activities have been undertaken, mostly by entrepreneurs and incubators. There is as much interest from the private sector and non-governmental organizations, as there is from the public sector, to unlock entrepreneurial talent through incubation. However, there are some systemic challenges that must be addressed for the STI parks to thrive and increase their contribution to socio-economic development in Ghana. In addition, there are no large scale STI parks, though there is the opportunity to develop one or more large scale STI parks as anchors for technology or industrialization zones and/or to have place-based innovation districts.

Based on the findings above, recommendations are proposed in four areas as follows:

Recommendations on STI Policy Implementation

i) Ghana has had several recent STI policy reviews and interventions which have resulted in shifts and updates from the 2017 STI Policy to the 2024 STI Policy. There seems less need for policy improvements than for support in the implementation of the STI policy and the development of monitoring and evaluation mechanisms of its implementation.

ii) In respect of STI parks that were provided in the 2024 STI Policy, development of implementation strategies for the interventions identified in the STI policy are warranted, with particular emphasis on:

a. Strengthening of R&D investment and financing of STI projects across the STI ecosystem;

b. Instruments and approaches to finance the establishment and operations of STI parks to achieve the 2024 STI Policy objectives;

c. STI park management, including fundraising for STI park, creating new ventures and enhancing incubation processes; and

d. Mechanisms to enhance collaboration and cooperation across various government ministries and agencies and between private and public sectors.

iii) The government needs to increase public funding for STI and in particular STI parks, to mitigate innovation risk. Targeted STI public funding will assist crowding in private sector funding. An example is one of the STI funding instruments that has been used in South Africa to forge HEIs-industry STI collaboration, i.e. the Technology and Human Resources for Industry Programme under which governments provide funding to both HEIs and industry for R&D in areas of strategic importance to industry, with a specific focus on developing STI human capital (South Africa DTIC, 2024).

Recommendations on Institutional Strengthening

a. Given the critical role of the CSIR there is room for improved certainty in STI coordination in Ghana. Clarifying roles between the CSIR and the anticipated GIRC Centre, would ensure effective STI coordination. Lack of clarity will derail the implementation of the STI policy.

b. The government could organize events and campaigns to increase awareness of STI parks and their positioning as an enabling intermediary in the strengthening of the actor relationships within the innovation ecosystem.

c. The private sector could partner with the government for mutual interest in various ways, including funding national priority initiatives run by the STI parks, locating companies' facilities (which may include laboratories and production) in the STI parks, integrating small enterprise development as part of their business strategy to develop suppliers and collaborators. The medium to long term positioning of the CSIR—IIR Innovation Hub offers an opportunity for this in areas of mutual interest between the private and public sectors. To that end, the CSIR-IIR could strategically focus on supporting innovators who work on innovations of relevance and interest to the private sector. Private sector could also be involved in the governance structures of the STI parks, thus providing private sector perspectives on making the parks more attractive to private sector. In the case of the CSIR-IIR for example, the governance structure or advisory boards could include private sector representatives.

d. Establish a programme to attract foreign companies to establish a presence in the STI parks. The programme could target specific STI priority sectors of the economy, as part of implementing Ghana's Technology Transfer Act and its Regulations. This can be linked to the country's Foreign Direct Investment attraction strategy, industrialization as one of the Key Objectives of the 2024 STI Policy and can be supported by GIPC.

e. At HEIs it is important to carefully manage the establishment of STI parks to align with R&D intensity and outputs, as well as the needs of the surrounding communities. There are opportunities for the HEIs to be used as hosts for STI parks that serve broader community needs – this could also enable access to equipment and expertise that is at the HEIs.

Recommendations to Promote Inclusiveness, Particularly Gender

a. Sensitization campaigns could be held to increase participation of females in the study of science, technology, engineering and mathematics as well as technical and vocational education training. Scholarships should be provided to brilliant but needy ones.

b. There is a need to collect gender-disaggregated data to inform policy objectives and options that encourage gender equality and women empowerment in the STI ecosystem.

c. Deliberate programmes such as mentorship, training and networking could be developed by the STI parks to support female entrepreneurs.

d. Government-initiated or led STI parks should have a policy to foster a more gender inclusive workforce.

Recommendations on Capacity Development

i) Given the different elements and dynamics of STI parks, capacity development interventions should cover the different aspects or tracks of STI parks.

ii) The capacity development needs identified through the present analysis as well as by the stakeholders in the country's STI ecosystem include:

a. Establishment, operation and management of STI parks, with particular emphasis on differentiation between the various forms of STI parks, for example, incubators, accelerators, innovation hubs, science parks and technology parks. Specifically, they relate to:

- How to successfully launch an STI park, including determining the appropriate size, infrastructure and configuration of an STI park;
- How to select the priority focus areas of an STI park;
- Financing of innovation projects and management processes;
- Establishing and strengthening innovation networks and open innovation platforms;
- Innovation management processes and managing new products and services development;
- STI parks' management, including fundraising for STI parks, building an innovation-enabling organization, creating new ventures and enhancing incubation processes;
- STI parks' sustainability, including how to identify revenue streams for the STI parks;
- Management of R&D projects;
- Intellectual property rights management, with particular emphasis on how to deal appropriately with intellectual property rights issues, including technology transfer as a means of building industrialization and innovation capability;
- How to promote STI parks to policy makers and broader stakeholders such as private sector, HEIs and civil society; and
- How to position an STI park as a development partner to government in service delivery and implementation of the country's industrial and STI policies.

b. Training for incubator managers in respect of effective management and governance of STI parks, such as how STI could create solutions and opportunities in Ghana and how to build alliances with HEIs to initiate entrepreneurship initiatives as early as possible.

c. National innovation systems and entrepreneurship, including the building of ecosystems for start-ups, incubation practices, venture building and portfolio management.

d. Research and its impact assessment, including harmonizing research with the business sector, making research results accessible and creating transparency.

e. Access to relevant tools/consumables for entrepreneurs' innovations supported by the STI parks.

f. Awareness of the importance of TVET skills in the Ghana economy and the role of STI parks in promoting innovation amongst TVETs.

g. Training for facilitators at STI parks to acquire international accreditation standards in the fields and programmes offered by the STI parks (e.g. the DTI suite of vocational training programmes, to make the graduates internationally recognized or work with multinational companies located in Ghana that often require international accredited vocational skills).

h. Green businesses, circular economy, digital space and technology, development of new business models and renewable energy among others, as the emerging areas that are confronting STI parks, for which there is a dearth of expertise and experience.

i. Effective Public-Private-Partnerships in the establishment and management of STI parks, with exposure to case studies of effective models where PPPs have worked.

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