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Science, technology and innovation parks in Mozambique

Assessment and policy issues

Technical cooperation outcome

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Abbreviations

AU	African Union
CIUEM	Centre of Informatics of Eduardo Mondlane University
ENPCT	Empresa Nacional de Parques de Ciencias e Tecnologia
FDI	Foreign Direct Investment
FNI	Fundo Nacional de Investigação (National Research Fund)
GDP	Gross Domestic Product
GERD	Gross Expenditure on R&D
GIKES	Gauteng Innovation and Knowledge Economy Strategy
HEIs	Higher Education Institutions
IASP	International Association of Science Parks
IGEPE	Institute for the Management of State Holdings
MOSTIS	Mozambique's Science, Technology and Innovation Strategy
MSTHE	Ministry of Science, Technology and Higher Education
NDS 2035	National Development Strategy 2015–2035
NSTIS	National Science, Technology and Innovation System
R&D	Research and Development
SADC	Southern African Development Community
SDGs	Sustainable Development Goals
STIPS2023	Science, Technology and Innovation Policy and Strategy 2023
STI	Science, Technology and Innovation
UEM	Eduardo Mondlane University
UNCTAD	United Nations Trade and Development

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, 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 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 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 to bolster expertise and augment capacity in these developing countries, enabling them to formulate effective, cohesive policies and institutional frameworks conducive to their STI parks' development.

The Government of Mozambique has long recognized the importance of Science, Technology and Innovation (STI) in driving economic development and reducing poverty, beginning with the approval of the Policy on Science and Technology and its Implementation Strategy in 2003. Over the years, the government has maintained its commitment to fostering a conducive STI ecosystem, issuing more than 50 related policy initiatives. The National Development Strategy (2015-2035) further underscores STI's role as a key driver of economic growth and a solution to social challenges through enhanced research and innovation. The STI Policy Framework complements this by promoting a favourable environment for development, encouraging stakeholder collaboration and aligning efforts with national priorities to advance sustainable development.

Recognizing the importance of STI parks early on, the government established the Maluana Science and Technology Park, which became a cornerstone of Mozambique's innovation landscape. The creation of the Science and Technology Parks National Corporation (ENPCT) in 2015 further solidified this commitment. As a state-owned agency, ENPCT is tasked with designing, constructing, operating and managing STI parks to drive scientific, technological and business innovation.

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

1. The STI park ecosystem in Mozambique is a critical component of the country's development strategy, given its role in fostering innovation and economic growth. The establishment of the Maluana Science and Technology Park Is the first of its kind, focusing initially on ICT but also supporting various STI projects, including biotechnology and agriculture.
2. Mozambique's STI ecosystem shows strong potential for growth, driven by robust government support, a favourable legislative environment and the strategic location of Maluana Science and Technology Park. Emerging entrepreneurial activities in higher education institutions and opportunities for collaboration among universities, research institutions and the private sector further strengthen the ecosystem. Additionally, the diversity of sectors within STI parks and the presence of incubators at Higher Education Institutions (HEIs) provide a solid foundation for continued innovation and development.

3. Despite the potential of STI parks, several systemic challenges impede their effectiveness in Mozambique:
   - There is a lack of supportive conditions for STI development, reflected in low scores for innovation capability and STI adoption.
   - The ecosystem is characterized by insufficient synergies between universities and industries, poor linkages with the private sector as well as underdeveloped scientific and technical services.
   - There is a need for improved coordination among various actors involved in STI, which is essential for aligning efforts with government and industry priorities.

In summary, the STI ecosystem in Mozambique is positioned as a vital component of the country's national development strategy, focusing on fostering innovation through various STI parks, including the Maluana Science and Technology Park. Despite the growth potential, the ecosystem encounters significant challenges, such as limited funding, inadequate infrastructure and a lack of stakeholder coordination.

The following recommendations have been proposed:

STI Policy Recommendations: To advance STI parks, public-private partnerships should be explored, involving the private sector in governance and offering incentives for their participation. Strengthening ties between STI parks and higher education institutions is essential to commercialize research and boost entrepreneurship. Tax incentives for private sector investments in R&D and STI park activities are also crucial.

Institutional Strengthening Recommendations: Enhancing stakeholder coordination is necessary to broaden access to entrepreneurial opportunities. Increasing awareness of STI parks and their potential for large-scale developments is also important. The private sector is encouraged to collaborate with the government to fund national priorities and integrate small enterprise development. Attracting foreign companies to STI parks is also recommended.

Inclusivity Recommendations: Programs should be implemented to ensure inclusivity within STI parks, particularly by increasing the representation of women, youth and under-represented communities in management roles and among supported entrepreneurs. Government-initiated STI parks should adopt policies that actively promote a gender- and youth-inclusive workforce, fostering diversity that can positively impact economic outcomes.

Capacity Development Needs: Training is needed to strengthen the STI policy environment and the success of STI parks. This includes building analytical skills for designing innovation policies, managing STI parks, financing innovation projects and establishing innovation networks. Training in innovation management and fundraising for STI parks are also essential to foster innovation and entrepreneurship.

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I. Introduction to STI Parks

Evaluating science, technology and innovation policies and parks in Mozambique is a necessary step, as it seeks to identify gaps and take actions required to enhance the effectiveness of these parks as tools for socio-economic development.

Science, Technology and Innovation Parks (STI parks) are not just physical areas but the engines driving socio-economic development. They are where multiple tech- 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 organizations are based on space or property, including high-tech clusters managed by professionals to achieve goals beyond bringing businesses together in one location. STI parks are typically characterized by the co-location of multiple knowledge-intensive organizations, including research institutes. This strategic clustering leverages each entity's capabilities, knowledge and technology within a supportive and synergistic environment (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 one or more business incubators and research centres (Adamaitis, 2021; Amoroso et al., 2019).

STI parks operate under various ownership and governance models. Most are publicly owned, others function as public-private partnerships and some are owned by private firms or universities (UNCTAD, 2015; Van Dinteren, 2021). The ultimate ownership and governance model depends on various factors, including the context in which the STI park is established, its mission, funding sources and sustainability considerations. Notwithstanding the ownership or governance model, a science park should strive to meet three broad goals: create an enabling environment that nurtures new and existing ventures, foster innovation and promote scientific capabilities and facilitate commercialization of local technologies and innovations that contribute to the economic development of the region where located (UNCTAD, 2015; UNIDO, 2021; Nakamine, 2022). This emphasis on creating an enabling environment should inspire optimism about the potential for growth and development in Mozambique's science and technology sector.

In this paper, Science and Technology parks, incubators, innovation hubs, accelerators and similar organizations will be referred to as STI parks, given their shared objective of stimulating innovation. Here, incubators and accelerators are understood as instruments typically used by the STI parks to achieve their mandate.

Broad definition of STI parks is used

The report aims to provide a comprehensive overview of the STI parks in Mozambique. It seeks to examine the state of the STI policy environment and highlights challenges, gaps and opportunities for the further development of STI parks as an effective policy instrument. By highlighting key issues and recommendations, the report intends to lay the groundwork for capacity-building training programs to bolster Mozambique's STI capacities through STI park development.

II. STI Parks as a Development Instrument

STI parks contribute to national development by enabling the exchange of knowledge and technology, fostering the creation and growth of innovation-driven companies and offering customer-focused services, including infrastructure.

STI parks are a specific organizational form of Science–Business Linkages (SBL) in addition to contract research, which may range from joint development, collaboration or external support in commercializing new technologies to consultancy services in testing, certification and problem-solving.

The International Association of Science Parks (IASP) defines an STI park as an organization managed by specialized professionals[1] whose main aim is to increase the wealth of its STI community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. 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). STI parks have several goals, leading to mixed outcomes in terms of implementing their mandates. Notwithstanding, it is essential to understand the role of STI parks in economic development to provide a basis for establishing and implementing STI parks in developing countries, particularly in Africa.

STI parks are important intermediaries in any innovation ecosystem, bringing together various actors, typically government, industry, academic and research institutions, communities, entrepreneurs, financiers and other entrepreneurship support structures and markets (Thomas et al., 2020). As such, they play an essential role in promoting 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. To realize this, STI parks must recruit and co-locate new and existing knowledge-driven companies into their precinct and provide customized or flexible space, infrastructure & 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, instilling hope for the future of innovation. Given the importance of knowledge and tech-based businesses for economic development, STI parks have an important role in leveraging local knowledge resources to enhance the regional economy. In areas where local knowledge resources are limited, they facilitate the transfer of knowledge and technology from academia to industry and

There are different types of STI parks

[1] See www.iasp.ws.

external sources to the region (Sibanda, 2021). By co-locating knowledge, STI parks have the potential to play an active role in attracting investments into the area. These investments may include Foreign Direct Investment (FDI) when foreign companies are established in a country or investments in clusters within the STI parks driven by the growth of endogenous research and skills (OECD, 2021).

Given the diverse activities and roles that STI parks play, it is evident that they significantly manage and influence both regional and national innovation ecosystems. This includes capacity building, skills training, establishing and strengthening local and international partnerships and public-private sector engagements. According to Lyken-Segosebe et al. (2020, p.4):

> *"… technology parks contribute to local, regional and national economic growth and development 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 **evolve from university-led hubs to global innovation ecosystems**

The African Union Agenda 2063 greatly emphasizes African countries investing in and using STI for inclusive and sustainable development. It also encourages transitioning the continent's economies from resource-based to knowledge-intensive (AU Agenda 2063). As roadmaps to nurture technological development and innovation, STI policies need to be contextual to each country's development aspirations, level of development and economic and technological capabilities. STI parks are highlighted in many countries' policies as development instruments for promoting collaboration between universities, research institutions and industry. They are instrumental in creating technology clusters and driving economic development (UNCTAD, 2015). STI parks can effectively stimulate a culture of innovation and 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 commercialisation of university R&D, incubation and business services and accessing external sources of financing, including Venture Capital (VC) (Sosnowska and Lobejko, 2017).

Second-generation science parks are an evolution of universities and first-generation STI parks. However, they often are not necessarily located in immediate proximity or operate under the exclusive supervision of the 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 commercialization, they also focus on creating and supporting innovation-oriented businesses, emphasizing start-ups more strongly. They also offer a broad portfolio of high-quality services to that end (Sosnowska and Lobejko, 2017).

Third-generation science parks are characterized by cooperation with the private sector, academic institutions and government players. They function as aggregators of global and regional innovation activities. They offer a broad portfolio of innovation-related services and contribute to developing their regions' entrepreneurial culture through interactive, feedback-based innovation models. Their 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 run by professionals and experts. Most STI parks in the developed

economies today tend to be third-generation STI parks. Fourth-generation Science Parks are similar to third-generation STI parks. Still, they are typically found in industrialized, knowledge-based economies with well-established entrepreneurial cultures and a concentration of strong quadruple helix actors. As such, they function as coordinators and/or aggregators of innovation activities (Sosnowska and Lobejko, 2017).

While these models are in different parts of the world, their success often depends on a country's technological development and industries. Given the low technological base, limited R&D culture in both the private and public sectors, resulting in low research capacity and output and underdeveloped technological entrepreneurship culture, STI parks in many African countries need to have strategic intent to support frugal innovations and solve societal challenges. This includes facilitating technology transfer and adaptations of high-tech innovations from elsewhere to address local challenges effectively. Characterized by an under-developed private sector, low industrialization, rising unemployment and a growing youth population, STI parks in Africa are essential in fostering a culture of entrepreneurship. They support establishing and scaling high-growth start-up enterprises in sectors of strategic importance to their respective countries (Sibanda, 2021).

Services Provided by STI Parks

STI parks provide hard and soft infrastructure services (Ng et al., 2021). The complex infrastructure is property-related and includes buildings, land for development, connectivity, security, restaurants and meeting rooms. On the other hand, the soft infrastructure relates to support given to tenant companies, such as networking events, telephony services, mentorship and other linkages. It also facilitates ties to stakeholders within the innovation ecosystem. These conditions allow firms to be near knowledge-based institutions, supported by professional management that fosters networking activities, leading to knowledge sharing and mutual learning. For new and growing ventures, in addition to property-related services, a good address, access to land, land development and tenancy, the other vital benefits they can derive from a science park include innovation and entrepreneurship programmes (UNIDO, 2021).

STI parks host third-party incubators or operate independently (Sibanda, 2021). There is no one-size-fits-all to incubation in an STI park. What is essential is that there must be sufficient capacity, expertise and experience to support start-up businesses. In doing so, an STI park could run hackathons, start-up weekends, competitions and application processes to develop a pipeline of start-ups or entrepreneurs who can become part of the incubation programme. The support provided to the entrepreneurs by the incubators typically includes business advisory, mentor-ship, coaching, assistance with access to finance and markets, connectivity, space, facilities, meeting rooms, networking events, internationalization and marketing. Some of the support can be provided by a team of full-time professional employees of the STIP or, in some cases, external providers such as mentors (UNECA, 2023).

STI parks run innovation and dedicated skills development programmes that support the commercialization of scientific and technological research into industrial and commercial success (UNIDO, 2021). Innovation programmes may include technology transfer assistance and Open Innovation challenges focused on strengthening industry competitiveness. The skills development programmes aim to develop talent for industry needs and, in some cases, support entrepreneurs in their ventures. As STI parks are associated with tenancy and land development, some of their services must be directed towards crowding tenants and other stakeholders into the park to create an environment conducive to collaboration, networking and growth of tenant companies.

STI parks **provide hard and soft infrastructure services**

Success of an STI park **requires a well functioning ecosystem**

STI Park Stakeholders

The success of an STI park depends significantly on the various stakeholders within an innovation ecosystem. In the quadruple helix model, these stakeholders encompass government (local and national), the private sector, academic and research institutions and society, which includes entrepreneurs. Since STI parks are effective intermediaries when they are an integral part of an efficient triple or quadruple helix configuration (Albahari et al., 2022), there must be an enabling science, technology and innovation policy environment, as well as a well-established industry or private sector.

The government plays a vital role in STI parks and provides policy direction and financial support for the developmental aspects of their mandate (UNCTAD, 2015; Van Dinteren, 2021). STI parks are developmental instruments; as such, the government has a vital role in ensuring that the STI parks achieve their mandate. Government responsibilities include ensuring there are clear policy and regulatory frameworks with favourable conditions under which the STI parks can operate (UNIDO, 2021); providing fiscal incentives linked to domestic industry strength or to catalyze specific industries and developments; in most cases, making land available for the STI park project; provision of basic infrastructure and usually the initial investment for land and infrastructure development. Notwithstanding the significant role that the government plays, the government must not have undue influence or control of the STI parks once a governance structure such as a Board of Directors has been put in place.

The private sector, as part of the STI park stakeholders, plays a crucial role in several areas: contributing to the formulation of STI park strategy, ensuring the alignment of the STI park to industry needs, bringing in skills and professionalism to the management team (mainly where they are part of the ownership model ensuring the park's sustainable operation and acting as anchor tenants that attract other businesses or firms to co-locate in the STI park (Wang, 2019). Academic and research institutions provide R&D expertise, a skilled workforce that the industry can employ, access to expensive research equipment and knowledge and technologies for commercialization in the STI parks. These strengthen the park's science and technology base when they are located within or in proximity to the park (Cadorin, 2021; Wang, 2019). Ideally, the location of an STI park should be in an area that is accessible and with a solid science base (universities, research institutions, innovative firms) to build functional technology and innovation clusters (Wang, 2019; Van Dinteren, 2021).

STI Park Governance and Oversight

An appropriately constituted governance structure in the form of a statutory board is essential 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 STI parks and, in some cases, appoint the Chairperson.

Separating roles and ensuring accountability between the Board and management is crucial. In some cases, the CEO may serve as an executive director and, in certain situations, as an ex-officio member of the Board. However, for the sake of good corporate governance and to maintain the independence of the Board, the CEO should not also serve as a Chairperson of the Board, although they may chair the management executive committee. In some cases, STI parks may have 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 Board are responsible for selecting anchor tenants at the STI park or may delegate this to management committees (Sosnowska and Lobejko, 2017).

Successful STI parks comprise a diverse, dynamic and business-focused professional management team 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 communications (UNIDO, 2021). Given the dynamic environment in which STI parks operate, management must have the ability to adjust the STI park strategy to an ever-changing environment (Wang, 2019). The team should possess entrepreneurial skills and have members with first-hand experience in starting and running businesses.

Most failures in government-led STI parks in Africa have arisen when the CEO and some members of the management teams are appointed by politicians/ministers with little regard for the innovation ecosystem. These political appointees tend to have no technical background or understanding of innovation (Sibanda, 2021). The CEO of an STI park is responsible for implementing the strategy and strategic plan and managing the park on a day-to-day basis. The CEO is responsible for working with the Board to develop the strategy, implement the strategic plan and evolve effective business models. The CEO is also responsible for managing relationships with and expectations of the STI parks' multi-stakeholders and further development of the STI park, including scouting for resources.

Park Management and Staffing

STI parks are critical for driving regional economic development through scientific/technological developments, innovation and cluster creation. Certain critical factors should be in place for their success. Van Dinteren (2021) summarizes and reproduces these factors in **Figure 1**.

The success of STI parks depends on both external and internal factors. Concerning external factors, enabling national policy frameworks is essential for the innovation ecosystems to have an effective triple helix of industry, higher education institutions and government. Other factors include the industrial base, entrepreneurial culture, availability and strength of knowledge generation institutions, types of funding available to support entrepreneurial activities and location, with urban-based STI parks being more prone to success as they can attract a critical mass of tenant companies and entrepreneurs (Sibanda, 2021). 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 and there is a mix of sources of funding (grants, loans, equity).

The STI park should have good management, be well-networked in the innovation ecosystem and have good infrastructure to attract tenants. Good management in this context refers to an appropriate mix of technical, business, entrepreneurial, infrastructure development and marketing skills. Given that the focus is on STI, the management team must have good working experience and understanding of STI. The other skills are critical for the effective operation of the STI park as a business, given that there would be incubation or entrepreneurial activities, some real estate or infrastructure development and the need to market the STI park to internal and external stakeholders.

An appropriately constituted governance structure is essential for STI park oversight

Success Factors for STI Parks

As discussed earlier, the success of STI parks depends on both external and internal factors.

STI park **success hinges on policy support, skilled management, networks**

Concerning external factors, enabling national policy frameworks is essential for the innovation ecosystems to have an effective triple helix of industry, higher education institutions and government. Other factors include the industrial base, entrepreneurial culture, availability and strength of knowledge generation institutions, types of funding available to support entrepreneurial activities and location, with urban-based STI parks being more prone to success as they can attract a critical mass of tenant companies and entrepreneurs (Sibanda, 2021).

STI park performance **indicators include Implementation, outcomes and impact**

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 and there is a mix of sources of funding (grants, loans, equity). The STI park should have good management, be well-networked in the innovation ecosystem and have good infrastructure to attract tenants. Good management in this context refers to an appropriate mix of technical, business, entrepreneurial, infrastructure development and marketing skills. Given that the focus is on STI, the management team must have good working experience and understanding of STI.

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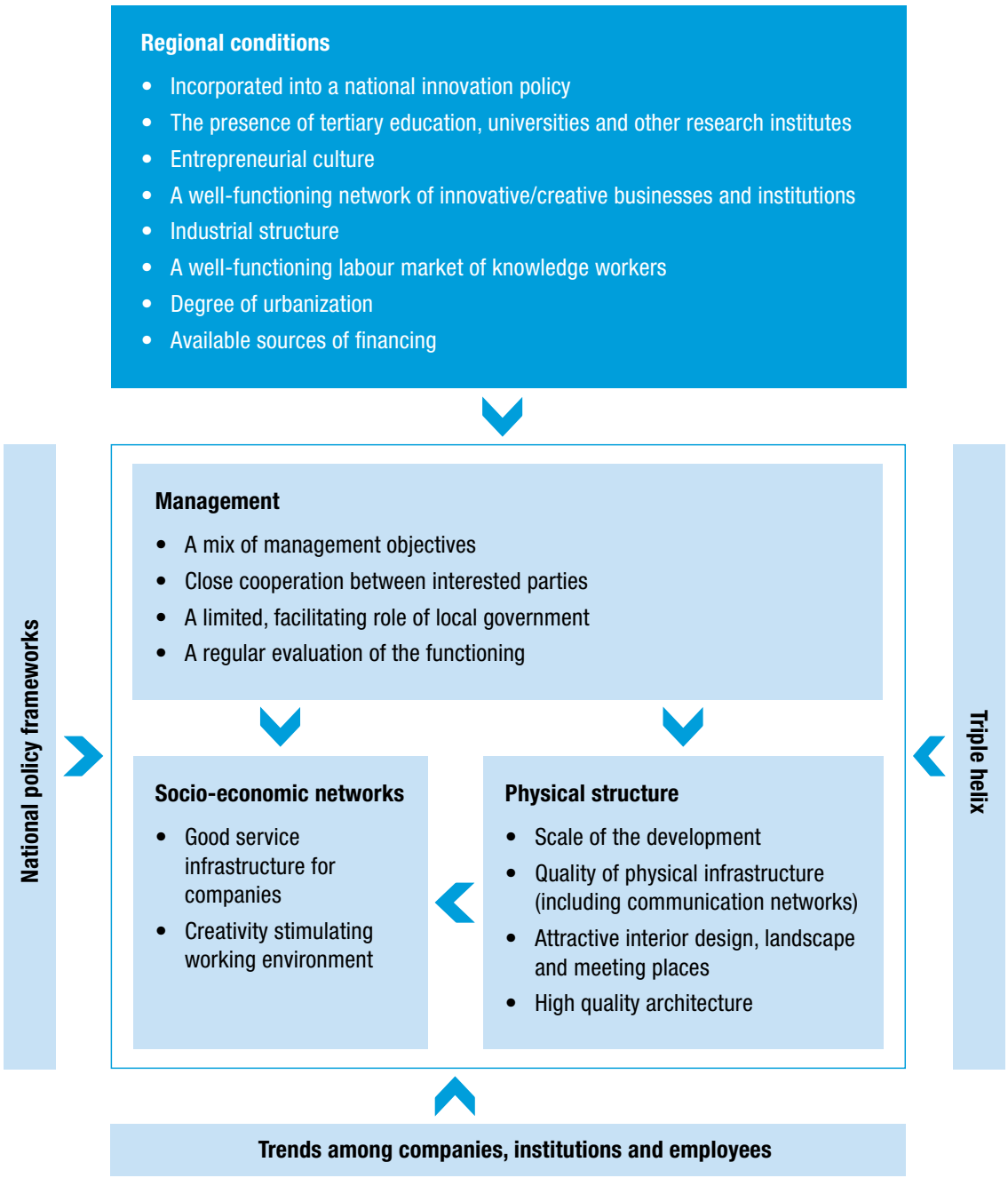
STI Parks Performance Indicators

There are a variety of matrices on which the performance of an STI park can be assessed. The accurate measure of success depends on the objects and objectives of the STI park and its original purpose for its establishment. **Table 1** provides a non-exhaustive set of matrices and indicators. An STI park needs 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 (e.g. the implementation). In contrast, others can be linked to the effectiveness of the initiatives implemented at an STI park (e.g. outcome indicators). The impact indicators measure the extent to which an STI park achieves its purpose.

Figure 1
Success Factors for STI Parks



Source: adapted from Van Dinteren, 2021.

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. • Per cent of land developed. • Number of companies located in the park. • Per cent 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 Park Ecosystem in Mozambique

Mozambique has established a policy framework to enhance the country's science and technology capabilities, promote innovation and support the development of a robust STI ecosystem. Acknowledging the significance of STI parks as vital tools for achieving its STI policy goals, Mozambique has initiated the development of multiple STI parks to foster innovation and technological advancement.

Mozambique is located in the Southern African region and is a member of the Southern African Development Community (SADC). The economy is dominated by the services and agriculture sectors, which account for 39.9 per cent and 26 per cent of GDP and employ 21.2 per cent and 70.2 per cent of the workforce, respectively (UN, 2021). The other sectors include extractives (coal and aluminium, with more significant potential from liquefied natural gas production) and manufacturing, which contribute less to GDP than the agricultural sector (World Bank, 2023). Despite the growth of the service sector over the past few years, it remains oriented towards less complex activities such as retail, tourism, travel and transport. More complex activities, such as ICT, finance/Fintech and professional and business services, have greater potential to drive inclusive growth and employment creation, owing to innovation and start-up formation prospects. For this sector to grow, the World Bank (2023) recommends Mozambique to *"consider … knowledge transfer schemes"* and *"promote innovation by improving education standards and investing in skills … to increase productivity and competitiveness."*

Almost 90 per cent of the economy is informal (UN, 2021). For the economy's structure to change, the country needs to increase its industrialization (IUCN, 2019), which requires significant investment in Science, Technology and Innovation (STI).

With a youthful population (at least 65 per cent of its population being under 24 and a further 28 per cent between 25–54 years old), STI policies and interventions are needed to provide an enabling environment conducive to technological innovation and entrepreneurship (Index Mundi, n.d.). This can offer excellent prospects for creating opportunities for the youth and ensure an active working population that can be beneficially engaged in technological developments, innovation and establishing high-growth start-ups.

STI in Mozambique's National Development Strategy (2015–2035)

Agenda 2025 (Comité de Conselheiros, 2003) details Mozambique's vision and strategies for a future government and society focused on national reconciliation and development. It lists four priorities:

I) Human capital (health and education),

ii) Social capital (social justice, access to land use and tenure, gender balance, national cohesion and youth),

iii) Economy and development (prioritization of agriculture, industry, mining, tourism and infrastructure, macroeconomic stability, protection of natural resources) and

iv) Governance (peace, social and political stability, democracy, legality and security) (IUCN, 2019).

Supported by the National Development Strategy 2015–2035 (Estratégia Nacional de Desenvolvimento), which focuses on industrialization, the four pillars of NDS2035 inform the country's STI policy to drive Mozambique's economic structural transformation (IUCN, 2019; Mozambique MEF, 2014).

Mozambique's STI policy aims **to drive sustainable industrial transformation**

Three of these pillars are enabling for STI parks:

i) Development of productive-based infrastructures, which includes industrial parks and Exclusive Economic Zones;

ii) Research, innovation and technological development directed to drive sustainable industrialization through the creation of specialized research and development (R&D) centres; and

iii) Articulation and institutional coordination, which focuses on the improvement of public institutions and creation of institutions that serve the industrialization strategy.

Science, Technology and Innovation Policy Framework

The Ministry of Sciences, Technologies and Higher Education (MSTHE) is responsible for Mozambique's Science and Technology Policy environment (Joaquim, 2017). According to the 2003 Policy, STI is a priority in

> *"increasing scientific knowledge and technological innovation, poverty mitigation and promotion of growth and accelerated economic development"* (UNESCO, 2021).

The policy is supported by Mozambique's Science, Technology and Innovation Strategy (MOSTIS 2006), which aims to develop a quality scientific research and innovation system. The initial 10-year implementation period of MOSTIS 2006 (2006–2016) highlighted innovation issues, promoted the inclusive application of science and technology-based approaches and fostered R&D, innovation and technology transfer in the productive sector (UNESCO, 2021). It also highlighted the importance of STI institutions and infrastructure, including STI parks. According to MOSTIS 2006, science parks and incubators are essential for:

i) Introducing new products and services in an innovation system,

ii) Facilitating the creation and growth of new, R&D-based companies and

iii) Providing platforms for strengthening relationships between universities and industry.

In 2021, the government initiated a process to review the Policy and develop an implementation plan for the period 2021–2031, namely the Science, Technology and Innovation Policy 2023 (STIPS2023), within the context *inter-alia* of Mozambique's National Development Strategy 2015–2035, Science Technology and Innovation Strategy

for Africa 2024 and AU Agenda 2063 (MSTHE, 2023). As of March 2024, this process was still underway, with a final draft submitted to the Mozambique Council of Ministers or Cabinet for approval (Pereira, 2023). According to MSTHE (2023), the main objective of STIPS2023 is to

> *"strengthen the NSTIS through the development and promotion of Science, Technology and Innovation in Mozambique, to boost the country's economic growth, sustainability and social well-being."*

Specific challenges relevant to STI that STIPS2023 seeks to address include (MSTHE, 2023):

i) *Limited enabling environment for STI development and limited supporting capacities to improve critical challenges* (for example, low indicator scores for innovation capability and STI adoption);

ii) *Weak innovation ecosystem:* characterized by limited synergies between universities and industries, poor linkages with the private sector and underdeveloped scientific and technical services;

iii) *Challenging entrepreneurial environment:* starting a business is time-consuming and costly (due to bureaucratic obstacles) and entrepreneurs' access to bank credit is relatively weak;

iv) *Low share of GDP dedicated to investments in STI (Gross Expenditure on R&D (GERD)):* Mozambique's current GERD of less than 0.33 per cent of GDP falls considerably short of its ambitious goal. The country aspires to dramatically increase this figure to at least 1 per cent of GDP while simultaneously developing a range of sustainable funding mechanisms and instruments to support R&D initiatives; 40 per cent of Mozambique's GERD is foreign-funded, with business expenditure as low as 1 per cent of GERD (UNESCO, 2021). Between 2010 and 2016, engineering and technology researchers declined as much as 43 per cent.[2] The amount of R&D undertaken in Engineering is meagre, with publications in Health and Agriculture research areas being 30-fold and four-fold, respectively, compared to Engineering (**Table 2**);

v) *Gender gap:* among engineering and mathematics graduates in tertiary education.

Table 2
Publication Research Areas

Period	Total	Health	Agriculture	Engineering
2004–2008	465	320	56	14
2009–2013	932	720	103	20
2014–2018	2105	1400	199	48

Source: UNESCO, 2021.

[2] According to UNESCO (2021), the computation of GERD in Mozambique includes personnel labour costs and current expenditure needed to support each and every employee (including researchers, technician, administrator and any support staff). There is a low contribution of Capital expenditure to GERD. Consequently, it appears that there is very little investment in undertaking R&D other than payment for researchers' salaries.

To address the above challenges, MSTHE (2023) elaborates on the specific objectives of STIPS2023. These objectives aim to strengthen the following areas:

i) Institutional links within the public sector and between the private and public sectors, particularly between universities and industry;

ii) The National Science, Technology and Innovation System (NSTIS) and building a culture of innovation in the country;

iii) R&D infrastructures; (iv) the executive coordination of the NSTIS and increase the involvement of civil society in STI activities;

v) The acquisition and use of scientific evidence when drawing up public policies;

vi) The human resource base (or human capital) in science, technology, engineering and maths (STEM), with an emphasis on increasing the number of women and girls in STEM courses;

vii) Innovation for production and industrialization, with a focus on training industrial SMEs at national level;

viii) Bilateral, regional, continental and international cooperation in STI to promote Mozambique's national interests while fulfilling external obligations.

It could be argued that STI parks could create an enabling environment that will help the country address some of the short-comings that STIPS2023 aims to tackle. However, STI parks are more likely to succeed when operating within an enabling policy environment. This is particularly important where the STI parks are government-led or initiated, as the enabling policy environment could unlock some form of government financial support.

STIPS2023 also seeks to increase GERD to at least 1 per cent of the GDP; leverage and drive R&I to solve pressing social challenges and achieve social transformation, focusing on national priorities articulated in Agenda 2025 and the SDGs; and develop national capacities, including regulatory frameworks, to encourage the development of cutting-edge technologies.

Strategic Pillar 3 of STIPS2023 provides policy support for STI parks or equivalent organizations in Mozambique, as illustrated by the three strategic interventions to Pillar 3, highlighted in table 3 (MSTHE, 2023).

Table 3
Strategic Pillar 3 – Strengthening the Industrial Innovation Ecosystem

Strategic Objective	Strategic Interventions
Build and use Mozambique's innovation capacities to stimulate sustainable and inclusive industrialization in line with SDG.	1. Strengthening national STI 2. Support for SMEs in technological research and innovation. 3. Strengthening STI to incubate technology-based companies.

Source: MSTHE, 2023.

STI Funding System

Public funding for research (the National Research Fund) is managed by an agency of the Ministry of Science and Technology and Higher Education, namely, Fundo Nacional de Investigação (FNI). FNI predominantly finances basic research, as there is no financing instrument for innovation-related activities, including commercializing applied research. As identified in STIPS2023, there is a need to increase funding for STI. Although there is some funding available for basic research, most of which goes towards covering overhead costs, there is a need for funding for applied and challenge-focused research, which has the potential to result in outcomes that can be commercialized and be the basis for start-up activities (Macanze, 2023).

Mozambique's VC funding and angel networks are nascent (Collier, 2020). A reason for this could be the shortage of innovative ideas linked with the productive capacity in the higher education sector, which has not placed much emphasis on applied research and entrepreneurship. Consequently, the low level of publications in STEM subjects (UNESCO, 2021) results in a poor pipeline of high-tech innovative ideas with the potential to be sources of high-growth businesses typically backed by venture capitalists and angel investors. The paucity of government grants and financing for innovation-related activities necessary to de-risk VC and angel network investments is also a challenge. Government grants are necessary to develop nascent ideas beyond proof of concept to a stage where there is market validation or traction, wherein VC and angel networks can take over (Faster Capital, n.d.).

Higher Education Institutions

At the end of 2023, Mozambique had 56 Higher Education Institutions (HEIs) comprising 22 public and 34 private institutions and several excellence centres and research facilities (UNESCO, 2021). The oldest (established in 1962) and the biggest comprehensive and multidisciplinary public Higher Education Institutions (HEI) in Mozambique, is Eduardo Mondlane University (UEM), located in Maputo. UEM is among Africa's top 35 universities (CIVIS, n.d.; Dos Remédios, 2021).

The STP project in Mozambique originated at UEM as part of the Mozambique ICT Institute. The project had three main priorities:

i) learning-oriented skills development,

ii) business incubation,

iii) short courses in support of the public and private sector and

iv) establishment of an environment to host innovative and technology-based enterprises (Macanze, 2023).

In 2002, UEM established the first tech business incubator in Mozambique, which has recently been refurbished and integrated into the Innovation Space. The initial phases of the UEM incubator have been implemented in partnership with and with the support of international partners such as the governments of South Korea, Japan and Canada. These partnerships have meant that the Mozambique ICT Institute has been able to offer ICT courses that were not available in Mozambique but were being offered abroad at the time. Other universities are starting to be involved in STI largely due to the evolving STI policy environment (Pereira, 2023). Currently, the Italian government supports the skills development mandate in the incubation and innovation space (Macanze, 2023).

The challenges observed in nurturing entrepreneurial skills led UEM to establish specialized higher schools, which started in 2008 to train future entrepreneurs. From 2025, entrepreneurship will be considered an elective cross-cutting subject in all courses of UEM (Macanze, 2023).

"There is a need for funding applied and challenge-focused research"

UEM pioneered Mozambique's first tech incubator, fostering innovation

Research Institutions

In addition to HEIs, several public research institutions in Mozambique are responsible for generating knowledge and contributing to innovation in the country (UNESCO, 2021). Some institutions report directly to the MSTHE, whereas others report to other functional ministries. Some of the notable institutions include:

- The National Institute of Health researches and promotes the commercialization and use of scientific and technological solutions to address Mozambique's health-related challenges;
- The National Institute of Fisheries Research is responsible for scientific research, management, conservation and effective exploitation of Mozambique's fishing resources.
- The Research Institute of Agriculture (RIA) researches and promotes the commercialization and use of scientific and technological solutions to address Mozambique's agriculture and food security-related challenges;
- The Centre for Research and Transfer of Technologies for Community Development promotes and develops innovations and their diffusion to address community challenges. It also supports intersectoral collaboration in research and technology transfer for community development (DIVARGI, n.d.);
- Centre for Research and Development in Ethnobotany;
- The Instituto de Investigacao em Aguas, or in English "Water Research Institute", carries out research and develops activities in water conservation and new technologies for water exploitation and rational use, including research aimed at mitigating the impact of climate change (UNEP, 2010);
- The National Centre for Biotechnology and Biosciences;
- Mozambique Engineering Laboratory is responsible for *inter-alia* or research, promotion and coordination of scientific research in civil engineering, contributing to innovation and technology transfer and the Academy of Sciences of Mozambique.

Entrepreneurship drives Mozambique's employment, competitiveness, and ecosystem growth

Entrepreneurship Education and Support System

Since 2008, a few public HEIs (including Universidade Eduardo Mondlane, Universidade Pedagógica and Instituto Superior Politécnico) have introduced entrepreneurship education in the curricula (Libombo, 2016). For these efforts to translate into a tech entrepreneurship culture and establish high-growth start-ups, there is a need not only to increase entrepreneurship education but also STEM skills and critical thinking capabilities, which are necessary to develop high-growth businesses.

Most entrepreneurs in Mozambique are informal and micro in scale, which is unsurprising since the informal sector accounts for approximately 40 per cent of the country's GDP (UNDP, 2021). Most micro-entrepreneurs are necessity-driven entrepreneurs and lack innovation and diversification (Technoserve, 2021). As such, the entrepreneurship ecosystem is still nascent and there is a need to develop an entrepreneurship culture (Collier, 2020).

Despite this reality, the local entrepreneurship ecosystem has been flourishing in the country's main cities, along with the global trend. The government's 5-year plan (2020–2024) and the national policy for employment (2016) centres entrepreneurship as a critical driver for improving employment, competitiveness and business formalization (WFP, 2022). As such, many multilateral and bilateral development organizations have started investing in different initiatives and entrepreneurship has become a cross theme among the leading development and sector initiatives (youth and female entrepreneurship, social and green, digital or agriculture) (UNDP, 2021).

Status of STI Parks in Mozambique

In 2012, the Council of Ministers established the Maluana Science and Technology Park to manage the flow of knowledge and act as a bridge between research and the market, expanding government support for tech entrepreneurship (Chemane, 2023). The Maluana Science and Technology Park was established as one of the four STI parks envisaged by the Government of Mozambique to foster the development of scientific and technological solutions by industry and scientists to address the myriad of social, health and infrastructural challenges facing the country (Nhampossa, 2023). All the STI parks are located along development corridors to facilitate trading by anchor tenants and all other companies that choose to be based at the STI parks (360Mozambique, 2021). Instead of establishing the STI parks in major urban areas or cities and/or proximal to universities and other R&D institutions, the STI parks are to be established in areas earmarked for future growth and development with the intention of including remote communities. The other three STI parks are to be located in the Northern and Central Regions as follows (360Mozambique, 2021):

- North Region (with a focus on Transportation and logistics): Muereti (Nacala-a-velha, Nampula);
- Central region (with a focus on Agribusiness):
  i) Dombe (Sussundenga, Manica) and
  ii) Mocuba (Mocuba, Zambezia).

The Government of Mozambique has created a science parks company, Empresa Nacional de Parques de Ciencias e Tecnologia (ENPCT) or, in English, "National Company of Science and Technology Parks." ENPCT is responsible for designing, constructing, operating and managing all four STPs. Its mission is to

> *"promote and facilitate scientific, technological and business innovation through the design, construction, exploration and management of science and technology parks in Mozambique."*

Some of its proposed services include (Maluana, 2023):

- Leasing of infrastructure and non-infrastructure spaces; territorial planning and urban planning;
- Data centres and business continuity; digital transformation, focusing on digitization and document management; information systems development;
- R&D Infrastructure and support services; business incubation and acceleration; professional education and consulting;
- Consultancy in the field of health, hygiene, safety, environment, corporate risks and emergencies; development of mobility solutions (prostheses, wheelchairs, etc.); development of solutions in the area of Civil and Mechanical Construction; development of community assistance projects within the scope of corporate social responsibility;
- Tax benefits to attract companies to set up in the STI parks (Maluana, 2023) in the form of;
  - Exemption in equipment imports and the first five fiscal years of establishing a company in the STI park;
  - A 50 per cent reduction in corporate income tax rate from the 6th to 10th fiscal year of operation in the STI park; and a 25 per cent reduction from the 11th to the 15th fiscal year.

One STP was created and three other STPs have been planned

ENPCT is managed by a four-person Board chaired by the Chief Executive Officer (Nhampossa, 2023). The other three members include two executive members and one non-executive. The Board reports to a General Assembly comprising the CEO of the Institute for the Management of State Holdings (IGEPE) or their representative, the ENPCT Board and an MSTHE representative. IGEPE reports to the Ministry of Economy and Finance. A Fiscal Council undertakes the functions of an Audit Committee, which comprises two representatives from the IGEPE. The ENPCT Business Plan and Annual Report are tabled before and approved by the General Assembly (Nhampossa, 2023).

To date, the primary responsibility of ENPCT is the management of the Maluana STP. As of November 2021, ENPCT was busy with the process of securing the land and zoning for the other two STI parks, as the Right of Land Use and Exploitation had been secured for the STI park to be established in Nacala (Nampula province) (360Mozambique, 2021).

Regarding entrepreneurship support, other than the government-backed STP project managed by ENPCT, several initiatives are mostly privately led – including incubators, some of which will be elaborated on below (Collier, 2020).

Maluana Science and Technology Park

Maluana Science and Technology Park is owned by the government

Maluana Science and Technology Park was established in 2012 as a wholly owned project of the Government of Mozambique under the MSTHE. It is in the country's Southern Region in Maluana, about 60 km from Maputo. The initial focus of the STP was ICT, although it supports all Science, Technology and Innovation (STI) projects, including biotechnology, agriculture and materials (Maluana, 2023).

Maluana STP is located on a 950-hectare land. According to the master plan, 360 hectares are designated for Phase I (STI projects, light industries, administration and housing) and the remaining 590 hectares (Phase II) are reserved for heavy industries. Phase I includes some bulk infrastructure and at least two buildings, such as the leading Science and Innovation Centre and the Data Centre. However, Phase II lacks any services. Phase I is also meant to house complementary infra-structure, including a restaurant, university, hospital, commercial centres and stadium (Maluana, 2023).

The STI Centre comprises four floors. In addition to hosting a data centre, meeting rooms and administration offices of the STI park management company, it also houses an incubator, training centre (four classrooms capable of hosting 100 students at any given time), four laboratories (networking lab with simulation of the data centre, open-source or digitization lab focused on eGovernment solutions, Microsoft lab and hardware lab), business centre made up of shells for investors or anchor tenant companies, an auditorium, exhibition spaces, a kitchen and a cafeteria area. The incubator comprises both open desk facilities and private offices for the management of incubated companies.

Some ongoing training activities and entrepreneurs supported by the incubator were observed during a site visit to Maluana STP in December 2023. Still, there was no evidence of any initiatives being undertaken in the laboratories. Partnerships with industry players and computer and mobile device hardware manufacturers could enhance the laboratories' activity and innovation level. Maluana STP is undertaking an ambitious yet fitting project by commercializing its data centre.

Incubation Programme: As of December 2023, Maluana STP management reported that 15 companies were incubated in its incubator programme, a growth from three start-ups in 2019 and nine in 2021 (360Mozambique, 2021). The incubator has a capacity of 90 companies. Although the extent of implementation and effectiveness of the Maluana STP incubator has not been validated, the incubation processes in its operating guidelines are robust and in line with international best practices and comprise pre-incubation, incubation and post-incubation support.

- The pre-incubation phase lasts three to six months and focuses on the ideation and establishment of a business venture;
- The incubation phase assumes that a company or business venture has been established and thus offers mentorship, market access and other support (transport, electricity, internet, space, HR and legal support, marketing assistance) for 3–12 months;
- There is also an acceleration phase of 12–21 months and graduation of 21–24 months. Unlike typical acceleration, where there is an industry partner and some funding associated with getting a market-ready product, the acceleration at Maluana STP appears not to have financing for the start-up.

Maluana STP holds shares from 7 to 50 per cent in the graduate companies (Maluana, 2023). Although this may appear appropriate for building a revenue model at face value, it poses a challenge as the incubator management expresses concerns that some companies opt to exit the incubator before graduation to evade this incubation obligation. Accordingly, the success of the Maluana STP incubation programme to date is not easy to assess. It may be important to map out all the founders, entrepreneurs and start-ups who have participated in the incubation programme to gauge the real impact of the incubator.

Centre of Informatics of Eduardo Mondlane University (CIUEM)

UEM's CIUEM **fosters cross-disciplinary innovation** to solve economic challenges

Eduardo Mondlane University (UEM), a leading HEI not only in Mozambique but in Africa, has an entrepreneurial culture, as evidenced by its role in incubating what became the Maluana STP, an innovation space and an incubator (Macanze, 2023). UEM's Centre of Informatics of Eduardo Mondlane University (CIUEM) is an important unit of UEM that focuses on ICT training, innovation and development. Over the years, it has developed innovation-focused initiatives, including an innovation space and an incubator. It encourages cross-disciplinary innovation amongst students at UEM from various faculties, including agronomy and forestry engineering, sciences, engineering, veterinary, medicine and social sciences, to work collaboratively in a team to solve challenges in various sectors of the economy. These teams use the innovation space created at UEM to develop and test the solutions (Macanze, 2023).

Recently, CIUEM has received financial support from international partners. This includes hosting faculty from a university in Italy to deliver lectures on programming, data mining, cybersecurity and other subjects. These efforts aim to enhance capacity-building in Mozambique and inspire some students to pursue entrepreneurial careers. CIUEM also provides ICT support to the rest of the university, including developing ICT solutions for the university's digital transformation. It manages the Mozambique Top Level Domain name, .mz and the Mozambique Internet Exchange. Some recent solutions include a university's student registration and finance systems. They have already developed a system for the management of university admission examinations. Most of their projects in the innovation space (which serves as a technology transfer hub and host of ICT4D initiatives) and the incubator are projects funded by the government of Mozambique, the United Nations Development Programme and the government of Italy (Macanze, 2023).

The incubator has been refurbished with the support of the Italian government and comprises an open space that can host up to 24 start-ups. As of the 20th of December 2023, 11 start-ups were in a 10-month incubation cycle. In addition, 25 young women finalists/recent graduates were preparing to participate in the next cycle, starting in February 2024 (Macanze, 2023).

IdeiaLab

IdeiaLab, is an entrepreneurship support organization, founded in 2010 by two Mozambican women. It is a for-profit organization that offers entrepreneurship and innovation programmes that are subsidized by development organizations or private sector entities, hence with its clients paying a reduced price. Its stated objectives are

> *"to empower people, accelerate learning and growth of companies and contribute to strengthening resilient, sustainable and inclusive ecosystems, societies and economies."*

IdeiaLab operates in different African countries, where they design, advise and implement projects and programmes to support entrepreneurship, MSME development and ecosystem strengthening, both digital and in-person, in any sector or industry. They offer a wide range of services, including capacity-building, training, technical assistance, business advisory, mentoring to community engagement, ecosystem interventions and space design and management. Their services are customized to meet the specific needs of each objective, target group and context. One example of those programmes is Orange Corners Mozambique, an initiative from the embassy of the Kingdom of the Netherlands, designed and implemented by IdeiaLab. Since 2018, IdeiaLab Orange Corners 12 has supported young entrepreneurs with innovative solutions to local challenges. This programme is funded by the Ministry of Foreign Affairs of the Netherlands and several private organizations, including Mpesa, Heineken, Van Oord and Grind Rod. Orange Corners supports entrepreneurs across Africa, Asia and the Middle East to develop skills and access networks, resources and facilities for their start-up or business (IdeiaLab, 2023).

The Orange Corners incubation programme by IdeiaLab is six to seven months long and is aimed at a cohort of 25 to 35 entrepreneurs. Since 2022, MSMEs have had access to the Orange Corners Innovation Fund for their financial needs. The interventions are sector-agnostic and span from generating ideas to the market. As of December 2023, Orange Corners (2023) has announced the continuation of their programme in Mozambique with IdeiaLab for the next five years.

IdeiaLab runs an acceleration programme for women in micro and small business called Femtech. This programme has empowered more than 200 women entrepreneurs in Mozambique. IdeiaLab (2022) also runs programmes for other companies such as iCreate, an initiative of Standard Bank, PUXAP backed by Vodacom, focused on technological and digital entrepreneurship; Climate Launchpad, supported by the Irish Embassy, Irish Aid, US embassy and other parties; MozGreen with the support of the Irish Embassy in Maputo, to name a few.

IdeiaLab empowers entrepreneurs, fostering resilient and inclusive ecosystems

IV.
Diagnosis of Challenges

Mozambique's STI ecosystem faces significant challenges, including a limited enabling environment, low innovation capability and weak university-industry synergies. The underdeveloped innovation landscape, poor private sector linkages and inadequate coordination among stakeholders underscore the need for improved collaboration and policy implementation to foster growth.

Improving the STI Ecosystem

Over the past decade, Mozambique has made significant progress in developing policies related to science, technology and innovation (STI). This has led to the recognition of STI parks and their potential to contribute to economic reform. As a consequence, the Science Parks project was established in 2012. The innovation ecosystem remains very nascent and has the potential to develop on the foundations of STI policy implementation.

There is scope for developing and strengthening the relationship between industry and academic and research institutions to foster a dynamic quadruple helix (consisting of academic and research institutions, government, industry and society) working together using STI to develop Mozambique's economy (Pereira, 2023). Coordination amongst the various actors, a responsibility of the National Directorate of Science, Technology and Innovation with guidance from the National Science and Technology Council, must be improved to ensure that STI contributes to government and industry priorities.

It is important to ensure that social entities and stakeholders, including marginalized groups, are involved in the process of improving the STI ecosystem. Organizations like the Secretaria de Estado da Juventude e Emprego (SEJE) and the Institute for the Promotion of Small and Medium Enterprises (IPEME) represent efforts to include these groups (IPEME, 2024; SEJE, 2024). Additionally, initiatives such as MUVA, a program focused on female economic empowerment and the Associação das Fintechs de Moçambique, the Fintech Association of Mozambique, aim to foster inclusive innovation and support marginalized communities (FinTech, 2024; OPML, 2024). By involving these diverse stakeholders, the STI ecosystem in Mozambique can better address the needs of the entire population and ensure no one is left behind in the country's development. The Mozambique STI ecosystem could benefit from diversified sources of funding. Given the current R&D funding status, the government needs to increase the financing of applied and challenge-based STI research and funding to commercialize R&D outputs on softer terms to reduce the risk and encourage private sector angel and VC financing. Given the reality of government

Mozambique's STI policies **lay foundations for inclusive economic growth**

budgets reducing year-by-year, other funding mechanisms should be explored. These include legislation to promote STI and investment by the private sector in STI, including incentives for R&D undertaken by industry collaboratively with the HEIs. According to the MSTHE, the government has tax incentives for attracting companies to STI parks or similar organizations to foster R&D investments and innovation. These are typically reduced taxation, tax holidays for the first five years for relocation to the STI park and tax exemption for importing equipment or funding the construction of buildings/research centres at the STI parks, as set out in section 3.7 above. However, the government has no financial measures to support the creation of new technology-based firms (start-ups). These are provided by donor agencies, such as Orange Corners or Emprega (Pereira, 2023). There is also no corporate tax relief for R&D and innovation support, debt guarantees or risk-sharing schemes.

Government-private sector could **collaborate to ensure wider accessibility to entre-preneurship support**

Although there are some private sector-led and foreign donor-funded entrepreneurship initiatives, as highlighted above, there is a need for better coordination to ensure that there could also be sharing or optimization of the use of resources and capabilities. For example, initiatives such as Ideialab that undertake training and mentorship could strategically do so in the areas that support other incubation and STI parks priorities in the country. Some of these initiatives are out of reach for those who might need or could benefit from them because they require participants to pay for the support and many entrepreneurs cannot afford the payments. There is an opportunity for government-private sector collaboration to ensure wider accessibility to entrepreneur-ship support. This could be made possible by the government providing financial support to Ideialab to extend its initiatives to underserved areas of the country or by providing tax incentives for costs incurred by Ideialab in extending its initiatives to such areas.

Although technical capabilities exist to implement innovation policy instruments within the public sector, essentially within the MSTHE, Mozambique lacks the analytical capabilities to design innovation policy within public administration (Pereira, 2023).

Improving the STI Park Operation and Management

The ICT sector formed the basis of the original concepts regarding Science Parks in Mozambique. There was a realization that Mozambique should work towards creating its products and not just be a consumer of ICT products and services developed by foreign companies. This realization was accompanied by an intent to build appro-priate human resources for developing and applying ICTs in different industries in the economy. As such, STI parks were seen as a vehicle that would catalyze ICT applications in Mozambique. Each of the four parks was to be thematic, focusing on supporting technological development, promoting STI across different sectors or themes, developing appropriate human resources and establishing and supporting start-up companies in each thematic area (Chemane, 2023).

Maluana STP is the first of the STI parks in Mozambique. It was established to focus on ICTs, promoting the use of ICTs in all sectorial areas of the economy and appro-priate human resources development in both software and hardware aspects of ICTs. With the establishment of the first building, the Centre for Innovation and Technological Development, through financial support from the government of India, the STP manage-ment team was to mobilize funding for other centres and buildings in the park. The second was the Data Centre, built with the Chinese government's support (Nhampossa, 2023). Since then, funding has not been available for establishing other centres, buildings, or thematic and strategic

programmes at Maluana STP. During the founding of the Maluana STP, the original vision was that by its fifth year, there would be between 2000 and 5000 technical and support personnel at the park, focused on developing and applying ICTs (Chemane, 2023). Some of the challenges faced include:

i) Lack of resources (funding of further development and programmes);

ii) Leadership without appropriate ICT technical background has occasionally been appointed to run the STP and veered from the original thematic focus and vision;

iii) Institutional form of ENPCT as a company and consequently pressure to generate own revenues and resources. As such, Maluana STP runs other unrelated businesses to meet these revenue generation expectations. The establishment of ENPCT and, consequently, Maluana STP as a company places undue pressure on its management to focus on revenue generation rather than the STP developmental mandate. IGEPE's mandate is profit-driven and there is no provision for a non-profit mandate for its established companies. This is supported by a statement issued on 29 November 2019, attributed to the Prime Minister, *"… the company [ENPCT] should become a source of revenue to reduce its dependence on the state budget* (Club of Mozambique, 2019);

iv) Low land uptake and lack of anchor tenants in the form of companies that take up and develop land parcels in the park. There are documented efforts as far back as 2021 to relocate the Ethnobotanical Research Centre from Namaacha, Maputo province and the Water Research Centre and Biotechnology Centre from Maputo City to Maluana Park. This relocation requires building about five laboratories for each centre to be fully operational at Maluana STP and no funding has been available (360Mozambique, 2021).

Maluana STP **faces institutional constraints, and lack of resources and tenants**

Whereas Maluana STP is predominantly funded by public funding, the incubators have minimal public funding. For example, in the case of Ideialab, 15 per cent of the funds are from the government, 70 per cent from development organizations, 10 per cent from the private sector and 5 per cent from entrepreneurs and others (IdeiaLab, 2023). Table 4 is an overview of STI parks and similar organizations in Mozambique based on responses from surveys conducted in November–December 2023.

Table 4
Overview of STI Parks in Mozambique

The focus of STI park and similar organizations	Types of activities underway
• Infrastructure development* • Tenant company support and provision of services • Skills development • Incubation of new innovative ventures • Innovation enablement incl. tech transfer and support • Enterprise development and employment	• Business services • Training • Applied research* • ICT services* • Financial Support[3]
The most significant contribution to the local economy	**Services for which engage external service providers**
• Employment creation • Highly skilled employment creation • Diversification of economic structure of local economy* • Creation of new technology businesses • Excellent working environment that attracts and retains high-quality technical staff • Improving service delivery*[4] • Attraction of Foreign Direct Investments (FDI)*	• Assist in raising risk capital and loans • Marketing services • Export activities • Access to market • Technology licensing, technology transfer and IP management • Improve management quality
Physical infrastructure and services provided to tenants/residence companies / non-tenants	**Sources of funding**
• Shared workspaces, coworking spaces and offices to rent • Laboratory or testing facilities* • IPR and licensing services • Manufacturing facilities* • Electronic communications (e.g., broadband, digital telephony, video conferencing)* • Other property related (e.g., meeting room hire, café, office cleaning, etc.) • Business support for growth or start-ups (e.g., finance, marketing, training, etc.) • Testing, certification and metrology equipment* • Assistance with recruitment of skilled personnel* • Networking and linking businesses from within and outside the park • Skills development training programmes,workshops, seminars • Innovation support (e.g., R&D, technology transfer services, etc.)*	• Public funding • Renting space to tenants* • Commercial services • International organizations • Other (unspecified)
Top challenges	**Key success and impact metrics**
• Talent management • Cash flow • Shortage of funding • Securing funding and sustainability • Technical assistance in business incubation and mentoring • Scaling activities	• Number of tenant companies and companies in incubation • Companies graduating from incubation • Number of jobs created • Intellectual property generated by supported companies*

Source: UNCTAD STI Parks Survey, 2023.

[3] IdeiaLab provides financial support to its supported startup companies through Orange Corners innovation fund (blend of 60% grant and 40% loan).

[4] * This applies only to publicly funded STI parks. The rest of the services are applicable to both public and private STI park organisations.

V.
Conclusions and Recommendations

Strengthening the capacity and effectiveness of STI parks is essential for fostering innovation and economic growth in Mozambique. Improving service delivery, attracting foreign direct investments and promoting stakeholder collaboration are crucial elements for creating a more robust innovation ecosystem. Recommendations are proposed to address funding challenges and enhance the overall management quality of STI initiatives.

Conclusions

- The STI environment in Mozambique is still nascent but shows excellent potential, with increasing entrepreneurial activities at higher education institutions (HEIs). UEM's Innovation Space contributes by offering training, mentoring and space for startup development, with significant potential for scaling;
- Mozambique has an enabling legislative and STI policy environment for establishing and growing STI parks. This is evident from the STI parks government's leading position on STI parks and the STI parks featured in the proposed new STI policy. Despite this policy environment, STI parks have developed far slower than initially anticipated, primarily due to a lack of funding for infrastructure development and programmes from the government. After the initial funding, which resulted in establishing the existing infrastructure and buildings in Maluana STP following the policy pronouncement of STI parks, the government has chronically underfunded STI parks. As such, no progress has been made on establishing the other proposed and initially announced parks, nor have there been any additional infrastructure developments at Maluana STP. Other reasons could be the challenges faced, as highlighted in this report, which hopefully should be addressed by the proposed new STI Policy (STIPS2023);
- There are excellent prospects for developing STI parks both in the public and private sectors, with the latter taking the form of incubators. The private sector is involved in incubators and existing programmes run by IdeiaLab have the potential for scaling;
- Funding is a significant challenge to establishing and growing STI parks in Mozambique. This has been a major constraint for Maluana STP's growth and expansion plans. Other envisaged STI parks, under the control of ENPCT, are unlikely to take off without significant government or international donor funding for master planning, design, provision of horizontal infrastructure and some buildings. Public and private sector funding is limited to programmatic interventions run by public and privately run incubators;
- Incubators at HEIs, such as the one at Eduardo Mondlane University, have the potential to contribute to STI development in Mozambique and could provide a pipeline for parks such as Maluana STP;

Funding challenges must be addressed to fully realize Mozambique's STI parks

Public-private partnerships can unlock the potential of STI parks in Mozambique

- The location of Maluana STP along one of the country's economic corridors is strategic. Still, it presents access challenges for entrepreneurs based in the capital, Maputo, given that it is at least an hour's commute. Although there is a shuttle bus to transport entrepreneurs and other tenant residents between Maputo and Maluana, it is not regular. In addition, the distance and one-hour travel time may be discouraging as it takes away two hours of work time;
- There does not appear to be a clear separation of roles and responsibilities between the Board and management of Maluana STP, given that the CEO chairs the Board and is also responsible for the day-to-day management of the STP;
- Maluana STP has been well designed and the current buildings are disability-friendly, offering lift and wheelchair ramp access. Whereas in the private sector-led entrepreneurship initiatives, there are deliberate programmes to increase women's participation in the innovation and entrepreneurship ecosystem, there were none in the interviewed public sector STI parks. Almost all the interviews held in Mozambique for this paper, other than those with IdeiaLab, had male participants. The management of Maluana STP is predominantly male dominated.

Policy Recommendations

Some policy recommendations on strengthening STI parks and similar organizations, from the desk research, interviews and surveys conducted, include:

i) Explore public-private partnerships (PPP) to develop STI parks in Mozambique. In particular, the government should engage the private sector in operation and further development of the Maluana STP and the other STPs proposed to be implemented by ENPCT. This could be in the form of having private sector representation on the Boards of Government initiated or led STI parks, incentivizing the private sector to establish a presence in the STI parks, or the private sector being involved in STI parks programmes. The other form of PPP could be providing long-term leases coupled with some tax incentives for the private sector to establish a presence in the STI parks;

ii) Improve the relationship between the STI parks and higher education institutions to enhance the commercialization of research results and position the STI parks as effective intermediaries between research and industry. To that end, the STI parks could design programmes they can implement at the HEIs to stimulate entrepreneurship and innovation, with the ultimate objective of identifying projects that the STI parks could further support. The programmes could include the STI parks running innovation competitions at the HEIs, boot camps and hackathons;

iii) Put in place tax incentives for STI parks in the private sector to support R&D and STI parks activities, including private sector-led small enterprise development in partnerships with STI parks and funding of innovations at the STI parks. This could be similar to South Africa's R&D tax incentive, which provides up to 150 per cent deduction for direct expenses incurred by the private sector in R&D (SARS, 2024). Other tax incentives could be directed towards private sector investments in VC funding for projects supported by STI parks.

Institutional Strengthening Recommendations

i) Cross-cutting Recommendations:

a. There is an opportunity for improved STI coordination to ensure access to entrepreneurial opportunities for more people in Mozambique. This should be a key focus in implementing the new STI Policy;

b. Increase awareness of STI parks and their positioning to host large-scale developments and focus on populating the STI parks;

c. The private sector could partner with the Government STI parks for mutual interest in various ways, including funding national priority initiatives run by the STI parks, locating their facilities in the STI parks and integrating small enterprise development as part of their business strategy to develop suppliers and collaborators. In addition, the private sector could use incubators to support innovators who can work on innovations that are of interest to them. The 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 the private sector;

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;

e. STI parks have the opportunity to be involved in the operationalization of STIPS2023, similar to what the Innovation Hub in South Africa was able to do so regarding the Gauteng Innovation and Knowledge Economy Strategy (GIKES) implemented in 2012 (The Innovation Hub, 2024; Sibanda, 2021). In the case of The Innovation Hub, the Gauteng Province government tasked it to be the implementation agency of the GIKES, which forced The Innovation Hub to develop a new organizational strategy that incorporated initiatives to implement the GIKES, some of which had funding allocations from the provincial government. Once STIPS2023 is approved by the Cabinet of the Government of Mozambique, it will be imperative to ensure there is funding for priority initiatives and for the STI parks to align their strategies to STIPS2023.

Effective management and collaboration are key to Mozambique's STI Park success

ii) In respect of Maluana STP:

a. Re-establish the Maluana STP as a government agency with a developmental mandate to foster STI in Mozambique rather than its current status as a for-profit state-owned company. The STP would benefit from this as there is a perceived view that it should be fully sustainable through its own revenues;

b. Maluana STP should focus on implementing the mandate of STPs and its founding mission, with a particular emphasis on programmatic offerings and appropriate base infrastructure to attract private sector companies to establish a presence at the STP;

c. Identify STI and STI parks' immediate, medium and long-term priorities to maximize existing infrastructure and prevent Maluana STP from becoming a *"white elephant."*

d. Enhance its incubation offering by providing additional human and other resources, including decentralized programmes to provide training, identify talent and create a pipeline of entrepreneurs and start-ups that the Maluana STP can incubate;

e. Maluana STP has the potential to develop stronger ties with higher education and research institutions, particularly to develop joint programmes that can be run both within and outside the park. Therefore, Maluana STP must strengthen its relationships with universities to increase its relevance within the Mozambique STI ecosystem. In this regard, the STI park could explore joint programmes and support innovations from the universities, including assisting HEIs with entrepreneurial training, access to equipment and collaboration partners;

f. To better appreciate the success of the Maluana STP incubation programme to date, it is recommended that a mapping of all the founders, entrepreneurs and start-ups that have ever participated in the incubation programme should be undertaken, with particular reference to where they are now, their journey since leaving the incubator, to gauge the real impact of the incubator;

g. Maluana STP should identify a close university to partner with to guarantee that they have a vibrant STI atmosphere of researchers, innovators, entrepreneurs, etc;

h. Governance: From a best practice regarding STI parks, the roles and responsibilities of the management team should be separated and distinct from those of the Board. To that end, it is recommended that Maluana Science Park have a clear separation between management and the Board. The Board should be chaired by a non-executive chairperson for full accountability and not the Chief Executive Officer or anyone in full-time employment at Maluana Science Park.

Inclusivity Recommendations

i) There is a need for deliberate programmes to ensure gender inclusivity in STI parks management and entrepreneurs supported by the STI parks, particularly those government-initiated and led.

ii) STI parks have the opportunity to be involved in the operationalization of STIPS2023, similar to what the Innovation Hub in South Africa was able to do so regarding the Gauteng Innovation and Knowledge Economy Strategy (GIKES) implemented in 2012 (The Innovation Hub, 2024; Sibanda, 2021).

Capacity-building Training Needs

To enhance the STI Policy environment and prospects of success with STI parks or equivalent organizations, stakeholders interviewed or responding to the surveys administered during this study identified the following training needs:

i) STI Policy Environment:

Capacity building in analytical capabilities for design innovation policy within public administration.

ii) STI Parks Development and Implementation:

a. How to successfully launch an STI park, including determining the appropriate size, infrastructure and configuration;

b. How to select the priority focus areas of the STI park;

c. Financing of innovation projects and management processes;

d. Establishing and strengthening innovation networks and open innovation platforms;

e. Innovation management processes and managing new products and services development;

f. STI parks management, including fundraising for STI park, building an innovation-enabling organization, creating new ventures and enhancing incubation processes;

g. STI parks sustainability, including how to identify revenue streams for the STI parks;

h. National innovation systems and entrepreneurship (including building start-up ecosystem);

i. Managing R&D projects;

j. Intellectual Property Rights management, with particular emphasis on how to deal appropriately with IPR issues, including technology transfer as a means of building industrialization and innovation capability;

k. How to promote STI parks to policymakers and broader stakeholders such as the private sector, HEIs and civil society;

l. Developing specific programmes to address gender and disability biases;

m. How to position the STI park as a development partner to the government in service delivery and implementing the country's industrial and STI policies.

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