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Science, technology and innovation parks in Uzbekistan

Assessment and policy issues

Technical cooperation outcome

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Abbreviations

AOI	Areas of Innovation
BES	Business Enterprise Sector
EU	European Union
FDI	Foreign Direct Investment
FEZ	Free Economic Zones
GIZ	German Corporation for International Cooperation
ICT	Information and Communication Technology
ID	Innovation Districts
IPR	Intellectual Property Rights
ITP	Industrial and Technology Parks
ITR	Industrial Technology Research
LL	Living Labs
OIS	Organized Innovation Spaces
PRO	Public Research Organizations
R&D	Research and Development
R&D&I	Research, Development and Innovation
SBL	Science–Business Linkages
SME	Small and Medium-sized Enterprises
STI	Science Technology and Innovation
STP	Science and Technology Park
TP	Technology Park
TITLI	Tashkent Institute of Textile & Light Industry
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNCTAD	United Nations Trade and Development
USAID	United States Agency for International Development
VCA	Venture Capital Association

Executive summary

The analysis of Uzbekistan's Science, Technology and Innovation (STI) parks identifies a number of critical areas that could lead to significant growth and advancement. The current state of STI parks, while showing a mixed performance in facilitating innovation and economic growth, presents an opportunity for substantial improvement and the potential for optimal synergy between research institutions, industry and governmental policies.

The findings reveal that although Uzbekistan's STI parks have seen progress in business incubation, they fall short in fostering significant technological innovation and economic diversification. Key barriers include weak collaboration between universities and industries, limited access to venture capital and an underdeveloped entrepreneurial culture.

The report emphasizes that successful science, technology, and innovation (STI) parks flourish in a strong regional environment marked by a lively entrepreneurial culture, active engagement from research institutions, and comprehensive support services for startups. For Uzbekistan, creating these conditions is not only important but also pressing. Key recommendations include strengthening the ability and engagement of STI park management, improving their access to financial resources and building stronger connections between universities and the private sector.

Uzbekistan can better leverage its STI parks to drive technological innovation and economic development by targeting these shortcomings through a bespoke mix of policy measures and capacity-building initiatives. The active involvement of government officials, policymakers, STI park managers and stakeholders will be crucial in aligning with best practices in successful STI parks globally.

Table of contents

I. Introduction

Uzbekistan's STI parks could play an increasingly important role in the country's economic growth by supporting innovation and commercializing research and innovation outcomes. This report examines the current state of these STI parks, while identifying challenges and opportunities, and recommend possible strategies and policies to strengthen their impact on technology and innovation-driven sustainable development.

Section II explains the role of STI parks as an instrument to support innovation-based growth with particular emphasis on middle-income economies. This section is complemented by an annex that reviews selected economies' experiences. Section III assesses the role of STI parks in Uzbekistan's innovation ecosystem. Section IV explores the challenges for STI parks in Uzbekistan, presents a taxonomy of these organizations based on fieldwork conducted in December 2023 and collected questionnaires to STI park managers. Section V draws analytical conclusions based on fieldwork. Section VI identifies challenges and recommendations relevant to Uzbekistan based on the world experiences. Section VII draws recommendations based on Uzbekistan's innovation policy stakeholders' views and reflects positive Chinese experiences in STI park support policy. Section VIII provides recommendations for future training programmes for Uzbekistani STI park managers and policymakers. The report is accompanied by an annex summarizing selected cases of STI parks in different economies.

II.

STI parks as instrument to support technology-based growth

STI parks support economic growth by linking science and business, enhancing knowledge flows and driving technological advancements. In Uzbekistan, they hold the potential to transform the economy by boosting R&D and fostering collaboration between academia, industry and government.

Definitions

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.

STI parks are just one type of what recent literature refers to as Organized Innovation Spaces (OIS) (Sanz et al., 2023). These should be distinguished from 'areas of innovation,' which encompass both virtual and physically unconstrained spaces. The International Association of Science Parks (IASP) describes areas of innovation as a dynamic mix of policies, programmes, quality spaces, facilities and high value-added services.[1] Such areas aim to (a) stimulate and manage the exchange of knowledge and technology between universities and companies, (b) facilitate communication between companies, entrepreneurs and technicians, (c) foster environments that encourage a culture of innovation, creativity and quality, (d) focus on not only companies and research institutions but also individual entrepreneurs and knowledge workers, (e) support the creation of new businesses through incubation and spin-off mechanisms while accelerating the growth of small and medium-sized enterprises and (f) operate within a global network that connects thousands of innovative companies and research institutions, helping to internationalize their resident companies.

Organized Innovation Spaces (OIS) encompass various areas dedicated to fostering innovation. These include six main physical forms: Science and Technology Parks (STPs), Innovation Districts (IDs), Industrial Innovation Campuses, Areas of Innovation (AOIs), Incubators and Living Labs (LLs).

The distinction between an industrial co-innovation campus and a science park lies in their primary actors. While a science park is typically centred around a university, an industrial co-innovation campus is often led by a large company, which may also be its initiator. At the core of these campuses, innovation centres are physical spaces or teams set up by organizations within global tech hubs, aiming to capitalize on the

STI parks are catalysts for **technology flow and innovation**

[1] See https://www.iasp.ws/our-industry/the-role-of-stps-and-areas-of-innovation (accessed on 24 September 2024).

startup, industry and academic ecosystems these hubs offer (Sanz et al., 2023).

A recent classification of OIS by Galan Muros et al. (2021) distinguishes between industrial parks, business parks, science parks, technology parks and IDs. IASP does not differentiate between terms such as 'technology park,' 'technopole,' 'research park' and 'science park,' instead using the acronym STP (science and technology park) to refer to all these types (Ng et al., 2019). According to IASP, these parks are run by specialists with the aim of contributing to the community's wealth by supporting a culture of innovation and strengthening the competitiveness of local businesses and knowledge-based institutions. IASP further notes that to achieve these objectives, a Science Park facilitates and oversees the exchange of knowledge and technology among universities, R&D institutions, companies and markets. It also supports the creation and growth of innovation-driven businesses through incubation and spin-off processes, offering additional services along with high-quality space and amenities.

IASP defines Areas of Innovation (AOIs) as specially curated locales designed to attract entrepreneurial individuals, skilled talent, knowledge-intensive businesses and investments. These areas combine infrastructural, institutional, scientific, technological, educational and social assets, enhanced by value-added services to promote sustainable economic development and community prosperity. The term AOIs can be applied to various models from urban or territorial initiatives with innovation activities across multiple areas to more focused projects such as innovation districts or knowledge quarters. What these models have in common is the presence of a management team who are responsible for implementing strategies to support innovation in the territory. AOIs fall under Organized Innovation Spaces (OIS), as they incorporate elements essential for nurturing a knowledge-based economy. They may include STPs, incubators, LLs, universities, technology centres and public agencies, all contributing to the area's economic growth (Sanz et al., 2023).

An innovation district is an existing urban area featuring a vibrant mix of knowledge institutions, companies and startups centred on innovation. Unlike STPs, IDs do not have a specific sectoral focus and often undergo urban restructuring. These districts offer a combination of business, recreational, retail and residential functions, setting them apart in their diverse offerings (Sanz et al., 2023). Another type of OIS is Living Labs (LLs), which are characterized by their user-centred, open innovation ecosystems that utilize systematic user co-creation approaches. LLs integrate research and innovation processes into real-life communities and settings, fostering innovation in various contexts (Sanz et al., 2023).

STI parks have been used in many economies, from developed to lower-middle income, to promote innovation-based growth. They are part of a broader policy thinking that underscores the importance of knowledge-based entrepreneurship and the linkages between R&D organizations and the commercial sector. The analytical framework that inspired this policy shift is the so-called 'Triple Helix'[2] model (Etzkowitz and Leydesdorff, 2000). STI parks play a key role in this framework by offering a physical space where the three helices (academia, industry and government) come together to promote innovation and economic growth. Although they were initially developed in more advanced economies, this approach has since gained acceptance globally. In particular, it is relevant for natural resource-based economies like Uzbekistan, whose strategic aim is to reduce dependence on several commodity-based sectors and restructure towards technology-intensive activities.

This study will use the term 'Science, Technology and Innovation (STI) park.'

[2] The triple helix model refers to interactions between academia (the university), industry and government to foster economic and social development.

In this report, the term will include science parks, incubators, accelerators, innovation hubs, innovation centres and technology transfer offices.[3] As a physical reality, STI parks include land, infrastructure and real estate facilities, thus having clear and well-defined boundaries. Industrial or business parks in Uzbekistan play an important role under the heading of free economic zones and have clear boundaries and new technologies for the country but are not necessarily linked with the R&D organizations. Most definitions of STI parks highlight that their most important characteristic revolves around R&D, innovation and technology-based business, which can be new to the country but not necessarily new to the world. Science parks are typically created to foster collaboration between R&D organizations and local entrepreneurs or companies, with a focus on establishing connections with tertiary educational institutions or other research organizations (World Bank, 2020); encourage innovation through research and development by fostering collaboration between research institutions and companies (UNCTAD, 2023) or foster science-based growth poles to stimulate economic diversification away from declining industries (Nauwelaers et al., 2014).

Below are four key components of an STI park (figure 1):

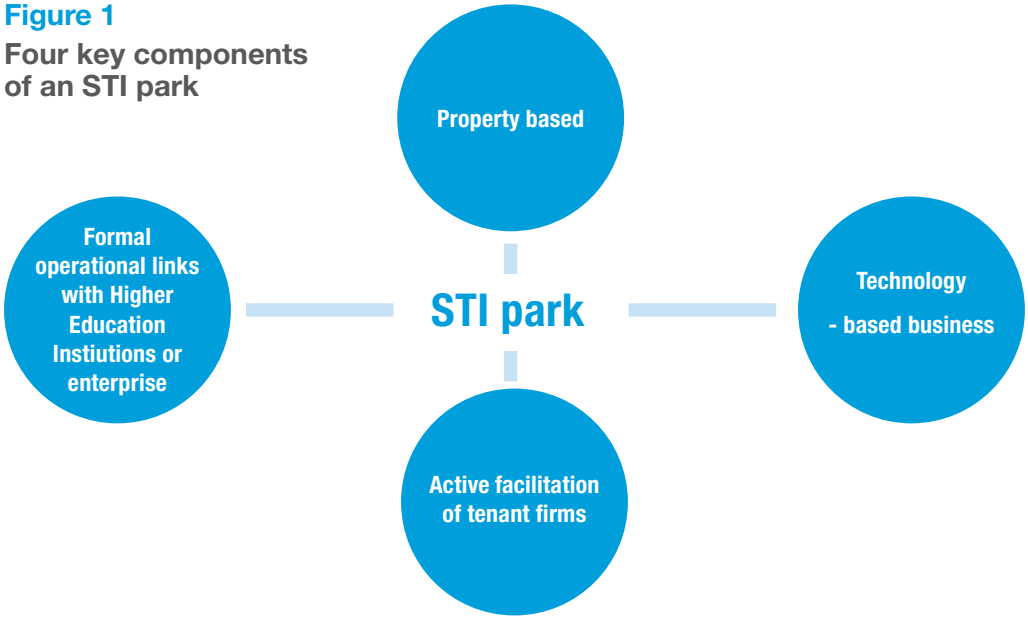
- property-based initiative
- formal operational links with a university or enterprises
- formation and growth of technology-based business of firm residents on-site
- active management function engaged proactively in assisting startups to grow.

STI Parks: Global Practices and Relevance to Uzbekistan

The success of STI parks is the outcome of the successful reconciliation of the four components, which are not necessarily equally developed. The property-based nature of these parks means they must achieve a certain rate of return to cover investments in physical assets. However, the rates of return can vary greatly based on the actual characteristics of the real estate in different economies. The emergence of technology-based businesses depends on the development of domestic R&D capabilities. In a lower-middle-income economy like Uzbekistan, such businesses are typically local market-oriented pioneers

STI parks foster **knowledge exchange, innovation and economic growth**

Figure 1
Four key components of an STI park



[3] For an exhaustive overview of different definitions of these categories, see Galan et al. (2021).

STI parks thrive through **strong ecosystems, partnerships and support**

but often face the challenge of adapting and assimilating foreign technologies. The presence of formal or informal connections between R&D organizations and local enterprises will largely depend on the technological capabilities of the business sector, as well as the quality and level of R&D within universities and public research organizations. The extent to which tenant firms receive active support for growth will hinge on the level of engagement by park management. However, even highly active management will ultimately be limited by these other three factors.

STI parks, in essence, provide indirect support for technology-based firms. They create the organizational context that is expected to favour the emergence and growth of domestic technology-based businesses. However, realizing this potential is not solely determined by what happens inside the park, but also by the nature of the innovation ecosystem in which parks operate, particularly the technological capabilities of local firms and the R&D capabilities of universities and public research organizations (PRO).

The multi-component nature of STI parks, together with their support for technology-based businesses, underscores the complexity of their assessment as an innovation policy instrument. This complexity is further highlighted by the significant gap between policymakers' optimistic views of STI parks and their actual, assessed outcomes, as demonstrated by the selected cases of STI parks in the Annex to this report.

The overview of conceptual or definitional issues and assessments of STI parks suggests that agreeing on factors crucial to STI park's success is challenging. These factors are both internal and external to STI parks, as the outcome crucially depends on complementarity. According to Zieliński et al. (2014), the Polish Agency of Enterprise Development has isolated the following success factors based on the experiences of parks in various countries:

- proximity of a university that actively encourages entrepreneurship and close relations with scientists;
- an atmosphere of partnership between local administration, business and science;
- community acceptance for supporting innovation business and integration with local development plans;
- competent and involved management with a clear long-term strategy and skilled staff;
- access to venture capital;
- a focus on developing the area, with opportunities to expand and design spaces that foster creativity, interaction and innovation;
- access to enterprise support services and specialized pro-innovation services;
- developing active networking at various levels and assessing their effectiveness, creating technology firm clusters;
- selecting tenants to generate synergy among them, while identifying their needs and providing them with access to networks and services;
- high standards of technology and transportation infrastructure and surroundings that make the park an attractive place to live;
- functioning of a park technology incubator connected to a university's pre-incubation programmes and forms of start-up support; and
- marketing activities that build a positive image of the park enhance its attractiveness and highlight the success stories of tenant firms.

These factors are rarely found in a single case, especially in emerging economies. In such contexts, firms often have capabilities that do not align with those of universities. It is difficult to recruit skilled personnel for managing STI parks and venture capitalists and angel investors are usually hesitant to invest (Torres de Oliveira et al., 2022). Proactive and entrepreneurial management of an STI park is not sufficient on its own;

a large, diverse and well-established metropolitan economy is also required, along with a solid research base, entrepreneurial culture and active participation from stakeholders such as universities or research centres to support the establishment of the park (Mian et al., 2005; Mian et al., 2020). Furthermore, in emerging economies, the institutional context is often less supportive of IP protection, growth and diffusion and the national market tends to be smaller and less sophisticated, which further impedes the development of STI parks (Comins and Rowe, 2008).

These factors are part of the immediate STI park ecosystem and should be distinguished from the broader ecosystem factors that contribute to success. Through an extensive literature review, Poonjan and Tanner (2020) identified five regional factors that influence the performance of STI parks: universities and research institutes, industrial structure, institutional settings, financial support and urbanization.

The design and assessment of the STI parks should consider internal and external factors to understand how they influence each other. From this, it is evident that there is no simple blueprint for this task. The character of the tenants in STI parks often reflects the ecosystem where the park is located. Within that system, two key factors influence knowledge transfer or opportunities for STI Park assisted technology upgrading:

- the level of regional demand from firms for knowledge produced by universities and PROs located in the same region; and
- the supply of knowledge with potential commercial applications from universities and PROs.

When these two factors complement each other, this will positively influence the success of STI parks. However, if they are in a mismatch, the bridging role of STI parks will face structural challenges (Eun et al., 2006). STI parks represent a middle ground for organizing SBL and their development is influenced by the capacities of companies and universities, as well as the R&D system (Albuquerque et al., 2015; UNIDO, 2021). However, research shows that the Chinese case confirms that SBLs are fundamentally driven by the characteristics of the firms rather than the intensity and quality of the study conducted at the PRO&UNI (Atta-Owusu et al., 2021).

The most common SBL policies and STI park models are rooted in the Triple Helix framework, which focuses on the commercialization of knowledge from public R&D, especially in knowledge-based industries and knowledge-intensive services. The aim is to facilitate direct links with industry to maximize the capitalization of knowledge. The close integration of public R&D with the industrial world should be stimulated by establishing STI parks, technology transfer offices and other intermediary organizations. Also, tax incentives and other regulatory measures should be geared toward this objective. The extent to which this approach is relevant for emerging economies depends on the level and quality of R&D in the public sector and the scale of knowledge-intensive industries and services.

Academic research is generally built around openness and scientific excellence, whereas the business sector values proprietary technology and commercial relevance. These different imperatives require different organizations and strongly limit the 'hybridization of R&D,' which follows the Triple Helix approach. Unless the two sectors are distinctly organized and valued, the R&D will be short-term and only applied-oriented. In the long term, this will erode the excellence of public R&D. On the other hand, the business sector may find R&D knowledge in the public sector irrelevant, limited or inappropriate to their needs. However, academic research has found that in developed country contexts, a shift towards the industry has not undermined basic research (Fini et al., 2011). This can be explained by the developed R&D capabilities of firms that benefit from basic and applied research at universities and PRO.

No simple blueprint exists **for designing successful STI parks**

STI park models evolve with the **capabilities of firms and R&D**

Still, university spin-out companies can emerge only if there is a robust support mechanism at universities and available venture capital.

Science-business linkages (SBL) depend on the capabilities of firms, public research organizations (PRO) and universities. As these capabilities change, the models of STI parks and SBL should also change. For example, the Chinese approach has shifted from close integration to gradual separation between academia and industry in less than two decades (Eun et al., 2006).

For lower-middle income economies like Uzbekistan, the policy focuses on the commercialization of the results of public R&D and the integration (hybridization) of academic and commercial R&D may be appropriate in some niche areas. However, this approach ignores the weak absorptive capabilities of local firms that deploy foreign technologies and whose productivity is driven by production and investment, not R&D capability (Fedyunina and Radosevic, 2022).

The overall approach focusing on commercialization via patents reflects a narrow view of SBL, which overlooks other commercialization and knowledge transfer mechanisms. Informal contacts with professional networks, the flow of graduates from university to industry, joint R&D, research and consultancy contracts, conferences, exhibitions are often even more critical than commercialization via patenting (Bradley et al., 2013). This is particularly relevant in the context of emerging economies with high expectations of promoting the patenting of publicly funded research. This is particularly relevant in the context of emerging economies with high expectations of promoting the patenting of publicly funded research. These are unlikely to be met given the low level of public R&D funding, university teaching orientation and the increasing role of IT for which conventional IPR are unsuitable for promotion (see So et al., 2008).

Different modes of SBL and different models of STI parks correspond to the various stages of economic development and the multiple capabilities of firms in each country (Lee and Kang, 2010). In the initial stages, firms face significant problems in production and management and require consultancy services and problem-solving skills rather than R&D. In the middle stages, firms tend to establish some in-house R&D capabilities and require external assistance through contract R&D or joint projects. In this stage, SBLs are the most developed. Only in mature stages do firms have strong in-house R&D capabilities and have less need for direct assistance from Public Research Organizations & Universities (PRO&UNI). However, the extent to which SBL will develop depends on the R&D capabilities of PRO&UNI, their academic or practice orientation and policy support. Also, SBL will depend on the size structure of firms in the economy, where larger firms are often more prone to cooperation. Smaller firms would require much more support via intermediary organizations like industry associations, innovation or productivity centres, PRO, etcetera. However, the most significant determinant is whether the firm conducts continuous R&D.

When the capabilities of both firms, PROs and Universities are undeveloped, SBLs and STI parks are weak and often ‘empty places.’ In these cases, which characterize many emerging economies, links develop more through consultancy services by PRO and Universities. In these cases, firms tend to rely on foreign knowledge through licensing, FDI, joint ventures or reverse engineering. A case in India shows that the existence of research capabilities in PROs and universities does not mean they will engage in SBL or commercialization (Ravi and Janodia, 2020). A lack of adequate resources and infrastructure, teaching orientation and dominance of publications as criteria of excellence as well as weak technology transfer mechanisms are some of the explanatory factors for this situation.

Still, economic development and firms' upgrading capability can be further supported through strengthened SBLs and STI parks. China offers good examples of the importance and the evolving nature of the SBLs**.** Universities in China were actively establishing their own start-up companies because the industry firms, even leading ones, were less capable of absorbing R&D results from public research organizations (PRO) and Universities. However, this gap has prompted the government to promote and advance technology transfer from PROs (Chen et al., 2020). The early involvement of PROs was the essential catalyst for the technology-based sector and the source of many contemporary Chinese global technology companies, such as Lenovo and others. Universities and institutes also faced financial pressure, leading to this situation. Chinese companies enhanced their ability to absorb knowledge and the academic system improved financially while emphasizing scientific excellence. Consequently, the prevalence of SBLs has decreased comparatively (Lee, 2021). As firms have upgraded their technology capability, the transfer modes have also been adjusting. They evolved from joint R&D projects with local governments and firms to PRO and firms incubated technologies and then to PRO-driven technology and research infrastructure platforms open to enterprises (Chen et al., 2022).

Box 1
Key messages

- STI parks foster knowledge and technology flow between universities and companies, enhancing innovation culture and supporting new business creation through incubation and acceleration.
- Successful STI parks integrate R&D organizations with businesses to stimulate innovation and economic diversification.
- The adaptation of STI parks is relevant to Uzbekistan's strategic goal of reducing dependency on commodity-based sectors and promoting technology-intensive activities.

III.

Uzbekistan's STI parks in innovation ecosystem of the economy

Uzbekistan's innovation ecosystem is diverse, focusing on production over research and development. Existing STI parks fall into several models, from standalone entities to university-linked and corporate venturing parks, each catering to different aspects of the country's innovation needs.

An innovation ecosystem brings together actors or entities whose goal is to enable technology development and innovation. The system is composed of material resources (funds, equipment and facilities), institutional entities (higher education institutions and support services, PROs, companies, venture capitalists and financial intermediaries), national, regional and local policymaking and funding entities (European Union, 2021). This one should add linkages among the actors, formal and informal rules and incentives for collaboration.

STI parks are one of the physical manifestations of the innovation ecosystem. They act as entities and/or intermediaries that bring together a critical mass of innovation actors, offer targeted services and provide a physical space for experimentation, interaction and networking. As pointed out earlier, STI parks reflect the degree of development of the innovation ecosystem and the technological capabilities of firms, PROs and universities.

The following section briefly overviews Uzbekistan's innovation ecosystem and presents the dominant models of STI parks operating in the country based on the fieldwork.

Uzbekistan's innovation ecosystem

The innovation ecosystem operates as the framework of opportunities and constraints within which STI parks can configure themselves and develop their business models and strategies. Some key features of Uzbekistan's innovation ecosystem are highlighted below.

Uzbekistan's innovation ecosystem reflects the import-substituting nature of its recent economic development trajectory. The economy's growth has been relatively good, but the downsides of Uzbekistan's growth model have also become more pronounced. The fundamental weakness is that growth has been jobless so far and the challenge is how to combine job creation with increased productivity and technology upgrading. Attempts to generate export-led growth have been much less successful. Also, the cost-efficiency of the current growth is questionable, given the high share of fixed investments, low job generation capacity and energy and environmental inefficiency.

Uzbekistan has diversified its economy towards the industry. However, the issue at stake is the costs and sustainability of initially import-substituting projects

Uzbekistan's STI parks develop within **an import-substitution focused ecosystem**

and how they can become successful exporting activities. In this case, an example is Uzbekistan's automotive industry, which enjoys protection but has severe problems in its export competitiveness.

Uzbekistan has significant opportunities for growth, thanks to its substantial natural resource base, particularly gold and petroleum gases, which make up 46 per cent of its exports, and a large share of young people. However, its trade advantages are heavily concentrated in cotton, precious metals, fruits and fertilizers, with limited diversification and competitiveness in other sectors. The share of medium- and high-tech sectors in manufacturing value-added products remains relatively low, though it is the highest in Central Asia at 20 per cent (Radosevic, 2021). The country's trade intensity (the ratio of exports and imports to GDP) is 66 per cent and above the average for lower-middle income economies. Despite this, the complexity of Uzbekistan's exports is low and has declined in recent years, mirroring trends in other CIS economies. Inadequate levels of integration into global supply chains, along with low rates of technology transfer and innovation, have contributed to underdeveloped productivity and competitiveness (ibid). Furthermore, Uzbekistan's primary export markets (Kazakhstan and Russia) are not particularly demanding. However, this low starting point offers significant growth opportunities for further technology upgrading and diversification.

The orientation of Uzbekistan's innovation ecosystem is more towards the support of production activities than innovation activities. Demand from the business sector is downstream, e.g. oriented (in decreasing order of importance) towards solving operational, engineering and innovation problems of the business enterprise sector (BES). In this situation, the production leads to R&D activities rather than R&D contributing to the innovative performance of the business sector.

Uzbekistan's innovation **ecosystem is driven by production, not R&D**

This situation is evident in the low and stagnant demand for local R&D, which ranged from 0.16 to 0.13 per cent of GDP between 2013 and 2022.[4] Uzbekistan's R&D system largely operates outside the business sector, with 80 per cent of R&D organizations being extra-mural with a large share of organizations conducting S&T services or non-research activities rather than in the business sector. R&D institutes primarily support the localization of production or the adoption of technology.

The relationship between firms and R&D organizations is mediated heavily through the ministerial and holding structures. Only recently have PROs and universities become more autonomous in dealing with industrial and agricultural enterprises.

Extra-mural R&D organizations (R&D institutes and universities) are often involved in S&T services and resolving production problems, but they are marginal in developing innovations with business enterprises. Data indicates that only 1.2 per cent of innovations were developed in collaboration with the R&D sector, including PROs and universities. Of all innovations, 92 per cent are introduced independently, with only 8 per cent involving partnerships with other organizations (UNECE, 2022). This pattern is consistent across both medium/large and small/micro firms. The only exception is the information and communication sector, where external organizations, presumably IT services firms, are developing innovations.

Finally, Uzbekistan's state policy is a significant component of its innovation ecosystem. The country has supported its industrial policy through presidential decrees. This industrial policy aims to diversify its economy's products as well as its industrial and technological structure by focusing on opportunities associated with import substitution. In that respect, state industrial policy strongly impacts innovation ecosystems and thus implicitly represents the country's innovation policy.

[4] Source: IUS Database, http://data.uis.unesco.org/ (last accessed on 27 September 2024).

Although Uzbekistan's developmental policy has declared a liberalization shift, import substitution remains strongly present. It is one of the dominant rationales for selecting projects supported through free economic zones and STI parks.

Uzbekistan would need to develop its startup ecosystem to diversify the economy and generate sources of endogenous growth. The analysis by the German Corporation for International Cooperation (GIZ) shows that Uzbekistan currently lacks a specific policy for startups (GIZ, 2019). Efforts to promote startups are divided among various government ministries, including the Ministry of Innovative Development, the Ministry for the Development of Information Technologies and Communications, the National Agency of Project Management and their affiliated organizations such as the Center for Advanced Technologies, Yashnabad Innovative Technopark, IT Park and the Mirzo Innovation Center. The level of coordination among these entities is currently somewhat limited, as each entity competes for a leading role in the startup sector. While some tax incentives are available for startups, these are generally only available to startups affiliated with these organizations.

Uzbekistan's STI ecosystem is not fully able to accommodate women and other vulnerable groups of population, including people with disabilities. Their inclusion is gaining some attention but challenges remain. The country's efforts to promote gender equality to help unleash Uzbekistan's full economic potential helped the country make it to the list of the top five improvers in gender equality in 2024 (according to the annually produced Women, Business, and the Law Index by the World Bank) (Seitz et al., 2024). Despite some positive developments in legislation and human capital, only around 25 per cent of startups in Uzbekistan are founded by women (Zufarov et al., 2023), suggesting there are still gender inequalities when it comes to access to education, finance and societal attitudes. Funding (including access to angel investment and venture capital) is a challenge that affects female founders to a greater extent (ibid). The World Bank's 'Country Gender Assessment Report' confirms the significant progress on gender equality made from 2017, but suggests that are persistent gaps, including in areas associated with economic activities and entrepreneurship (Seitz et al., 2024). The World Bank's "Country Gender Assessment Report" for Uzbekistan provides a comprehensive overview of gender issues across various sectors, noting the progress made in recent years but also the persistent gaps, particularly in economic activities and entrepreneurship (Seitz et al., 2024). However, traditional stereotypes continue to discourage girls and women from taking up careers associated with tech or entrepreneurship as just 36 per cent of men and 23 per cent of women in Uzbekistan believe that girls and women are suited for studying sciences or technical professions (UNDP, 2023). Despite a number of government's initiatives to address gender gaps—such as the GAP project led by the Ministry for Development of Information Technologies and Communications—there is still a need for more targeted measures such funding and policy interventions to support women in business and technology (UNDP, 2023).

According to the World Bank, persons with disabilities in Uzbekistan are about four times less likely to find a job than those without disabilities (World Bank, 2024b). In fact, over 25 percent of all registered persons with disabilities in Uzbekistan are recognized as capable of performing certain types of work, yet only roughly 6 percent are officially employed. There are significant incentives to employ persons with disabilities as an entrepreneur with 30 percent of employees consisting of persons with disabilities and other vulnerable groups is also entitled to receive state benefits and preferences (ibid). These incentives include profit tax exemption for enterprises owned by persons with disabilities that employ at least 50 percent of workers with disabilities, preferential taxation

with a 4.7 percent single social (payroll) tax for workers with disabilities, profit tax exemptions for companies for each percent more than the 3 percent employment quota, etcetera. In addition, subsidies are allocated to enterprises to cover the costs of adapting jobs for persons with disabilities. However, to ensure a greater level of inclusion of persons with disability and other vulnerable groups, further efforts need to be made to close these gaps. One example is the digital divide for people with disabilities which remains prevalent. In Uzbekistan, this group of population uses smartphones to access the internet 10 per cent less than those without disabilities resulting in the basic digital skills gap in this vulnerable group being at 32 per cent (UNDP, 2023). Additionally, digital skills programs targeting people with disabilities rarely address the specific needs of persons with disability, limiting their ability to take part in digital entrepreneurship.

As Uzbekistan's startup ecosystem is still developing, its macroeconomic significance remains limited. Instead, Uzbekistan's innovation ecosystem is currently dominated by a few large established businesses in the state sector or private companies closely connected to the state. These are natural resource-based industries (mining, commodities and agriculture) and import-substituting sectors like household appliances and automotive. In that respect, Uzbekistan's innovation ecosystem exists as a coexistence of several sectoral innovation ecosystems that are loosely connected.

The critical general constraint in all sectors of innovation ecosystems is entrepreneurship. The research shows that the distinguishing features of entrepreneurial ecosystems are the core of large established businesses, which are entrepreneurially led (entrepreneurial blockbusters) and entrepreneurial recycling – whereby successful cashed-out entrepreneurs reinvest their time, money and expertise in supporting new entrepreneurial activity (Mason and Brown, 2014). Additional elements of an entrepreneurial ecosystem are an information-rich environment in which this information is accessible and shared, its culture as well as the availability of start-up and growth capital, the presence of large firms, universities and service providers. Artel, a privately owned home appliance business group, is a good example of an entrepreneurially oriented large business in Uzbekistan. Also, other ecosystem elements are presented or emerging but are still poorly coordinated.

These features of Uzbekistan's innovation ecosystem suggest that at this stage of economic development there are concrete limits to STI parks, which are exclusively focused on commercializing results from the public R&D sector. This does not mean there are no niche activities in this domain. However, the features of Uzbekistan's innovation ecosystem at this stage would require STI parks, which are profiled around two other activities. First, STI parks are attached to PRO and universities, which would facilitate the building of the technological capabilities of local firms by

Box 2
Key messages

- Uzbekistan's innovation ecosystem is characterized by a focus on production activities rather than innovation, with low demand for local R&D and significant state policy involvement.
- The innovation ecosystem in Uzbekistan requires improved collaboration between universities, PROs and businesses to enhance technology transfer and innovation capabilities.

assisting them in problem-solving activities, certification activities, quality improvements and meeting regulatory standards for expanding foreign markets. Second, STI parks would bridge domestic and foreign firms in Uzbek variants of Chinese STI parks as places where foreign and domestic firms collaborate in production and innovation activities. Support for the two types of STI parks comes from research which shows that university-industry collaboration appears to be fundamentally driven by the characteristics of the firm rather than by the intensity and quality of the research conducted at the university (Atta-Owusu et al., 2021).

Models of STI parks and channels of technology (knowledge) transfer in Uzbekistan

The government of Uzbekistan has put in place a number of STI parks with the aim of supporting innovation and technology development. However, the rise in the number of parks, innovation centres, accelerators and business parks formed by universities, regions, firms and free economic zones makes it difficult to provide a reliable count, given the diversity of these entities and the lack of standardized definitions. For additional information, the UNESCO reports (2020a, 2020b, 2020c) provide further insights into the evolving legal framework and other sources cited in this report.

This section identifies five models (see table 1 below), including emerging types of broadly defined STI parks in Uzbekistan. These models reflect the features of Uzbekistan's innovation ecosystems and the search for new STI park frameworks. The classification of models in this report is derived from the limited fieldwork and as would be expected, none of the cases from which it is derived exist in the pure form. It still highlights the variety of Uzbekistan's STI parks and contains important policy lessons.

Table 1 synthesizes a discussion of different STI park models in Uzbekistan. The overview shows that Uzbekistan is actively experimenting with various forms of STI parks as part of its industrial innovation policy. The country has moved beyond the traditional model of standalone STI parks designed to foster the growth of innovation-based companies through incubation and acceleration. The new direction includes the establishment of a virtual IT park to develop an innovation ecosystem in IT services, as well as transforming Free Economic Zones (FEZ) into technology park-driven FEZ. These processes are state-driven and coordinated, alongside more bottom-up forms of STI parks that benefit from state support but are driven by internal entrepreneurship. Such examples include university-affiliated parks aimed at enhancing industry connections and STI parks (incubators and accelerators) that are part of corporate diversification efforts led by holdings.

Uzbekistan adopts diverse STI park models **to stimulate innovation**

The overview shows that Uzbekistan is actively experimenting with various forms of STI parks as part of its industrial innovation policy. The country has moved beyond the traditional model of standalone STI parks designed to foster the growth of innovation-based companies through incubation and acceleration. The new direction includes the establishment of a virtual IT park to develop an innovation ecosystem in IT services, as well as transforming Free Economic Zones (FEZ) into technology park-driven FEZ. These processes are state-driven and coordinated, alongside more bottom-up forms of STI parks that benefit from state support but are driven by internal entrepreneurship. Such examples include university-affiliated parks aimed at enhancing industry connections and STI parks (incubators and accelerators) that are part of corporate diversification efforts led by holdings.

All models share a common goal: to create innovation ecosystems, whether they are corporate-based, sector-based, university-industry or founded on the proximity of firms

within an STI park. The success of these models cannot be attributed solely to sound strategies and effective management. It also depends on the maturity of the existing or developing innovation ecosystem in which the parks operate. Therefore, managing an STI park goes beyond internal operations as it involves managing the broader innovation ecosystem as well. This is the meso level of economic organization, which requires greater collaboration among stakeholders, aiming to develop a shared understanding of the challenges and strategic goals.

Standalone STI parks

Standalone STI parks are designed based on models of parks in developed economies. The original plan was for these places to be incubators and startup accelerators of new technology-based startups. Examples of these STI parks in Uzbekistan are INNO TP and TP Yashnabad. Regarding the four components depicted in figure 1, the emphasis is on managing property, ensuring that the place is financially sustainable and hosting technology-based businesses.

Table 1
Types of STI Parks Models in Uzbekistan

	Property	Operational links with universities or enterprises	Technology based businesses	Active facilitation of tenants	Overall profile
Stand-alone STI park	Key to financial sustainability	Secondary or as space for MSc and PhD research	Lacking true technology-based businesses	Basic assistance in legal matters	Designed as a driven model but significant constraint in low supply of technology-based firms. A strong sustainability vs technology upgrading trade-off.
STI parks with a strong focus on enhancing university-industry linkages	Secondary issue	Key rationale	A focus is less on incubating and more on collaborating with enterprises in the industry.	Secondary issue due to focus on collaboration	Various approaches to improve linkages with industry. When well-designed, this could be a significant contributor to the industry's technology upgrading.
Virtual IT Park	The issue is present only in the case of access to IT infrastructure (5G network)	Still secondary in R&D: Significant in training and education	Key focus but significant financial hurdles	Weak mentoring system	Numerous coordination challenges in enhancing the IT innovation ecosystem.
STI parks as corporate venturing	A secondary issue	Not developed	Essential as a component of the corporate venturing programme	Active through equity stake or complete control	It is a promising route of technology diversification but confined only to a few entrepreneurially driven large firms.
FEZ and Technopark-driven Free Economic Zones	Key issue for FEZ as they become financially independent	Non-existent in the case of FEZ but significant in the shift towards TP-driven FEZ	Reduced to selection in the case of FEZ; Key future challenge for TP-driven FEZ	Reduced to non-technology support (in the case of FEZ); Essential to technology upgrading of TP-driven FEZ	TP-driven FEZ is a significant step forward but requires good coordination among stakeholders.

The links with universities and active facilitation of the growth of tenants are nominally also their aims, but in both cases, they are either secondary or undeveloped. In both cases, tenant companies meet the formal requirements of technology-based business when they introduce products produced for the first time in Uzbekistan.

In that respect, the criterion of being a national innovator is met and residents can enjoy several privileges (profit tax, customs tax, land tax and VAT reliefs). The dual objectives of these two STI parks, aimed at promoting technology-based firms and achieving self-financing, are frequently at odds with each other. As a result of these competing requirements, they or one of the two tend to shift gradually or temporarily more towards renting office space rather than providing places for the growth of startups. In the case of INNO TP, links with universities do not go beyond offering their teaching (lab) facilities. The active involvement in facilitating the growth of tenant firms does not go beyond assisting firms to deal with administrative issues.

In some cases, a strong imperative for STI parks to be financially viable, combined with the extensive tax reliefs and other benefits (see Annex) opened the possibility for STI parks to be businesses that can generate satisfactory returns. Financial incentives designed to attract tenant companies make this possible as currently, investments in technoparks tend to lean more towards real estate than industrial ventures with technological goals. On the other hand, the technopark aligns with the policies for diversifying the economy. A notable example is the newly established Chirchik Technopark, developed through investments from a state enterprise, the Republic of Tatarstan, two Uzbek entrepreneurs and currently housing both Russian and local companies meeting import substitution criteria. However, the focus on technological upgrading or industrial policy objectives is limited as STI parks may gradually move towards taking in already established companies or joint ventures, deriving most revenue from rental income and potentially lessening their role in technology upgrading the economy. The challenge is determining when this policy direction might incur greater costs than benefits, particularly if it fails to boost exports or create added value. Chirchik serves as a standalone STI park, heavily centred on property and real estate activities.

STI parks with a strong focus on enhancing university-industry linkages

This emerging model demonstrates the reorientation of universities towards a third mission or impact activity. The experience in Uzbekistan, in this respect, varies from highly successful models to models still in very early stages. Moreover, in successful cases, the relationship with the industry does not even include a formal STI park; nevertheless, in practice, there are durable linkages with the industry.

The best examples of this model are university technoparks that are closely integrated with universities, playing a pivotal role in teaching, research and vocational training. Two good examples are the Turin Polytechnic Technopark and the Technopark of the Tashkent Institute of Textile & Light Industry (TITLI TP). The two technoparks are very effective in their respective fields and serve as important hubs for training and skill development in the automotive and textile sectors. Rather than relying on tenants as a primary revenue source, these technoparks succeed through collaborations in joint vocational programmes, equipment rental, prototype development for enterprises and support in solving production issues.

In both cases, technoparks (TP) function as separate organizational units within their respective universities, carrying out a variety of activities all related to the university's teaching areas. While they include some technology-based firms, these are considered to be part of the TP's structure. The Turin TP is particularly good at sourcing technological knowledge in

STI parks balance **financial viability and fostering innovation growth**

automotive technologies from abroad. Some of this success is ensured through hands-on teaching and applied projects that focus on localizing and adopting technologies imported from elsewhere. The TP is closely integrated with Turin Polytechnic University, making it difficult to distinguish its activities from those of the university as a whole. Similarly, the Tashkent Institute of Textile and Light Industries has strong connections with the textile sector and TITLI TP has put in place both modern facilities and a solid strategic plan, with success largely attributed to modern equipment and close work with local enterprises in training textile specialists. The primary focus of both TPs is not on incubation or acceleration but on close cooperation with enterprises for training and R&D. Both TPs maintain strong operational ties with their universities and relevant industries. They actively manage firms within the TP, though this is not their main priority. Given their university affiliation, property management is a secondary issue for the Turin TP. Property management at TITLI TP is integrated into its overall operations resulting in its effective performance.

Some universities can have very developed operational links to enterprises. Still, without established TP, or even when they have them, they are secondary to the overall intensity of their links with the business sector. Tashkent Institute of Irrigation and Agricultural Mechanization Engineers National Research University (TIIAME) is probably the leader in collaboration with industry in Uzbekistan. This is the result of their strategy, which is focused on a good combination of theoretical teaching and practical training and a good and systematic understanding of the production problems of agricultural firms. TIIAME represents a variation of STI parks without a formally organized park. The scale and range of this institute's third-mission activities (such as innovation and technology transfer) are developed to the extent that this function is well integrated and inseparable from teaching and research as the other two essential functions of the institute. TIIAME has an innovation park, which is mainly active in precision farming. However, this is just one of the lines of activities of the university, which is very active in various technology transfer, acquisition and development activities.

Science-industry links remain undeveloped **but hold significant potential**

In contrast, while science-industry links remain underdeveloped at some universities, there is potential for growth. At Tashkent State University, third-mission activities are still in the early stages; however, the university has demonstrated ambition to expand these efforts by establishing an office to support staff in technology transfer. A crucial precondition for this progress is the modernization of equipment, as current facilities limit what can be offered to industry partners. The Biochemistry Laboratory of the National University of Uzbekistan has promising potential in this respect, as the lab is transitioning to increase its research and teaching excellence based on the new equipment. In addition, they plan to engage in certification services through a spin-off company.

In both the Biochemistry Laboratory and Tashkent State University, modernizing research and measurement equipment is vital for improving the quality of teaching, research and offering testing, certification services and R&D collaboration with industry. In this regard, the Biochemistry Laboratory at the National University of Uzbekistan displays significant potential. However, the slower pace of modernization at some labs in Tashkent State Technical University hinders their move towards stronger industry collaboration and third-mission activities.

From these three successful cases, the key to fostering science-industry linkages lies less in the specific organizational structure of an STI park and more in the R&D capabilities that are directly relevant to industry needs and their ability to support the industry in adopting and implementing new technologies.

Virtual IT Park and the emerging innovation ecosystems

In addition to property-based STI parks, Uzbekistan has established a virtual IT Park, managed by the Ministry of Information Technologies and Communications (MITC). Benefits provided to its residents, based on the principle of extraterritoriality, extend until 2028. These include reduced income taxes (7.5 per cent), exemptions from corporate and social taxes (0 per cent) and customs payments on the import of goods and services (0 per cent) (USAID, 2022). According to the same source, the IT Park serves as a key hub, attracting organizations involved in Information and Communication Technology (ICT) education, hardware development, robotics, internet service exports, data storage and processing, online commerce, fintech, digital education, e-governance, Internet of Things, MedTech and agrotech. Furthermore, the IT Park hosts initiatives like 'Smart City' and 'Safe City,' events such as the Hack4Region hackathons, and is engaged in conducting 5G trials with UCELL in Tashkent and other regions. The IT Park also supports startups through incubation and acceleration services and fosters IT skill development. It oversees programmes like the IT Academy, One Million Coders and Digital University (USAID, 2022).

In 2020, independent from the IT Park, the government established the Agency for Youth Affairs, which focuses on developing entrepreneurship and startups and running incubation and promotional programmes.

According to USAID (2022), 450 companies have since become IT Park residents, benefitting from tax and customs benefits and more than 100 startups have been trained through the incubation and acceleration programmes. The availability of local graduates and opportunities for acquiring programming skills, coupled with the low capital intensity of IT services, has led to the mushrooming of local IT start-ups. However, in this context, Uzbekistan seems a latecomer, not in Central Asia but when compared to other ex-transition economies.

The feature of this segment of firms is their high concentration in Tashkent. Most of them are digital start-ups.[5] They are generally disconnected from local scientific research; some develop digital high-tech (rather than deep technology or deep tech) solutions without sizeable initial capital injections. Many IT start-ups focus on developing more straightforward IT applications for local businesses and do not qualify as digital high-tech firms.

Uzbekistan's Virtual IT Park **fuels emerging tech ecosystems**

In 2020, the Uzbek Venture Capital Association (VCA) reported[6] that fintech, e-commerce, e-marketplaces and EdTech make up most of the country's startup scene, with most businesses focused on the national market (TUZ Ventures, 2021). The StartupBlink Global Startup Ecosystem Index 2023 ranks Tashkent's startup ecosystem at 561st globally, a significant improvement of 165 places from 2022, though still relatively low. According to UZ VCA (2020), the main challenge for Uzbek startups is closing the gap between early-stage startups and venture capital funds that typically prioritize more established startups. To address this, a regulatory framework has been introduced, covering instruments such as convertible loans, option agreements, crowdfunding agreements and limited partnerships.

According to estimates from the Asian Development Bank, Uzbekistan had nearly 1,200 startups in 2020, most of which were in the early stages of development, such as pre-seed and seed stages (Zufarov et al., 2023). At these early stages, many products are still in the design or refinement

[5] The distinction between digital deep tech and digital high-tech is quite relevant here. "Deep tech" solutions are rooted in significant engineering innovations or scientific breakthroughs and typically involve extensive R&D and substantial capital investment. On the other hand, "digital high-tech" includes solutions that do not demand the same level of effort, such as those in artificial intelligence, computer vision, blockchain, cybersecurity, IoT and related areas. See https://en.wikipedia.org/wiki/Deep_tech

[6] UZ VCA (2020) Uzbekistan Startup Ecosystem Overview July 2020.

process, with some not yet available on the market or only recently launched. Startups at this point often need extra funding for product development, hiring and business setup, making support from angel investors and venture capital crucial. Although a National Venture Fund has been set up and some corporate venture capital is emerging, a key challenge is the small number of mentors and the lack of incentives for them. A draft law, "On Startups," is expected to be adopted to clarify the definition of startups and establish principles and support measures.

Although the virtual IT park does not conform to the strict definition of the STI parks as it does not have property dimension as its key component, its three other components are highly relevant. The growth of technology-based companies is central to digital startups and one of the key challenges is the issue of active facilitation through mentorship and networking. While little is known about the links with the R&D system, they seem rudimentary. However, links with the education system currently play a significant role.

Large companies show little **interest in supporting Uzbekistan startups**

Uzbekistan's IT companies currently focus on the domestic market. The government aims to have one million programmers, putting the country on the global map of IT services. As a step towards this aim, around 300,000 people have completed online IT education programmes. However, despite these ambitions, the country has yet to see substantial progress. Its export of IT services (including telecom services) has remained largely unchanged over the last 15 years (UNECE, 2022).

STI parks as corporate venturing

STI parks may emerge as the result of corporate venturing, especially in the case of large holding companies. In the case of Uzbekistan, the situation in that respect is not very optimistic, though there are good examples of this model of STI parks.

The Startup Ecosystem Review 2020 (USAID, 2022) indicates that over half of startups in Uzbekistan experience a lack of interest from large companies in forming partnerships, which hampers scalability. Entrepreneurial ecosystems typically rely on established businesses led by entrepreneurs (entrepreneurial blockbusters) and on "entrepreneurial recycling," where successful entrepreneurs reinvest their resources to support new ventures (Mason and Brown, 2014). In Uzbekistan's case, the economy is largely dominated by state-owned commercial enterprises, companies and banks. Aside from a few exceptions, these entities are generally not engaged in developing the startup ecosystem, as it is often easier for them to purchase off-the-shelf foreign technological solutions (USAID, 2022).

In the private sector, two notable examples showcase the potential of large companies in fostering new businesses through STI parks. Technopark Tashkent LLC is a unique model, effectively operating as part of Uzbekistan's largest holding company, Akfa-Artel, with 6,500 employees across various established business lines under the holding's strong management. Meanwhile, TPLLC TASHKENT is wholly owned by Tashkent's administration and managed by 'Akfa Build.'

The city of Tashkent has a share in the ownership, enabling it to enjoy TP's privileges. However, in all respects, this is a fully established holding company, the biggest or only player in its respective industries, aiming to establish itself as a significant exporter. Its management has established growth strategies in several areas, and in many respects, this holding is one of the core players in the industrial development of the economy. Its growth results from three interrelated factors: a) strong initial domestic demand for household appliances, b) entrepreneurship and organizational capabilities of its private owners, and c) the facilitating role of the state, which pursued an active industrial policy of import substitution.

This has led to the further diversification of conglomerates, which is currently facing the initial challenges of globalisation. In this case, new ventures are de facto diversification investments of the holding in which the company controls all process stages.

An example of a partnership between large organizations and tech startups is UZCARD, an interbank payment system. USAID (2022) defines it as a successful example of how a systemic player can engage the sector by bringing together corporate expertise, funding and tech transfer and an example of how anchor companies in an industry can stimulate the startup ecosystem. UZCARD supports emerging startups in financial technology through its corporate Fintech Accelerator and the CVC fund 'UZCARD Ventures,' which was launched in 2021 by Uzcard and is connected to a USD 1 million corporate venture fund. 'UZCARD Ventures' invests in early-stage startups across different sectors of the economy, typically providing between USD 50,000 and 150,000 for a 10 to 20 per cent minority stake.

The Asian Development Bank (Zufarov et al., 2023) reports that the accelerator's goal is to grow Uzcard's network and operations by incorporating solutions from both local and international startups into the Uzcard system, including solutions to automate internal processes. After completing the 6-month acceleration program, startups may be eligible for venture capital investments from Uzcard's venture capital fund, which focuses on finance and other business sectors.

Both cases show the dynamism and impact that large companies may have on their environment. In the case of Artel, the system is closed within the company, whereas in the case of UZCard, it is open partly due to the nature of its industry. The key in both cases is that extensive holdings may operate as drivers of STI parks or innovation actors by supporting the formation of technology-based firms. The issue is how to stimulate state-owned companies to engage in corporate venturing and establish links with specialized suppliers, usually SMEs, in their respective industries.

STI parks-driven Free Economic Zones

The State Unitary Enterprise's Directorate for the Management of the Ohangaron Tech Industrial Technopark operates similarly to a free economic zone (FEZ). The park is structured as a cluster or value chain within the copper industry, covering the entire process from raw materials to final products. The copper cluster will focus on a new system of interaction between science and manufacturing, the development of new types of mining and metallurgical machinery and equipment, improvement of the training system, retraining and advanced training of personnel. Technopark residents can enjoy benefits from both FEZ incentives and those offered by the technopark. Local large firms in the sector will cover the cost of developing the cluster.

FEZs drive technology advancement through **industry clustering and innovation**

This case represents a significant new step as it introduces a much more active approach, which can lead to technology upgrading through clustering and the organizational form of technopark. As per figure 1, the Ohangaron Tech Industrial technopark aims to move from the more traditional FEZ model to one with closer connections between firms within the cluster. The park will be able to facilitate its objective to support technological upgrades by addressing challenges within the innovation ecosystem and shifting to a focus on science-industry linkages. The state enterprise's role in cluster management, along with property issues related to it being an FEZ, effectively qualifies this cluster as a fully-fledged STI park. In that respect, the Ohangaron Tech Industrial technopark represents an example of institutional innovation.

The Ohangaron Tech Industrial Technopark operates within the natural resource-based industry, which is often viewed as technologically stagnant and an area to shift away from rather than expand. However, recent research challenges this view as outdated and misleading (Morris et al., 2012). While countries rich in natural

resources must promote structural change and diversification, this should be done by building on existing capabilities within those industries, rather than diverging from them. Farooki and Kaplinsky (2013) highlight that countries like Canada, Finland and the United States developed their manufacturing sectors through a symbiotic relationship: manufacturing grew through its connections to the commodities sector, while extraction rates and productivity in the commodities sector improved through manufacturing ties. Traditionally, natural resource activities were seen as isolated, with few links to the wider economy. However, this perspective is changing as ICT has allowed small, knowledge-intensive firms to innovate across all sectors, including natural resources (Marin et al., 2015). Innovations in nanotechnology, biotechnology and new materials have transformed the landscape of natural resource industries, leading to a policy focus on the entire network of activities, including downstream linkages. Incidentally, this seems to be the focus of the emerging Ohangaron Tech Industrial technopark's value chain. This is a useful alternative to the current import substitution policy, which carries the risk of being about assembling imported parts without much capability building.

Box 3
Key messages

- Five models of STI parks have been identified in Uzbekistan: Stand-alone STI parks, University-industry linkage parks, Virtual IT parks, corporate venturing parks and Technopark-driven Free Economic Zones.
- Different STI park models allow for addressing diverse needs, from university-industry collaboration to fostering digital startups and enhancing corporate venturing.
- Similarly, different STI park models have unique challenges, including financial sustainability, strengthening university-industry linkages and supporting technological startups.
- The success of various STI park models in Uzbekistan can be further ensured with the help of custom support solutions and clear strategies.

IV.
Challenges for STI parks in Uzbekistan

Uzbekistan's STI parks face considerable obstacles, such as limited access to marketable projects, limited collaboration among research entities and businesses and inadequate funding for commercialization. Targeted policy interventions and further efforts to strengthen technology transfer activities and ecosystem collaboration can help address these obstacles.

Research, fieldwork and interviews undertaken as part of the UNCTAD project indicate that Uzbekistan's potential for innovative commercialization solutions in standalone STI parks is somewhat constrained. In particular, new technology-based firms developed by scientific and academic institutions face the challenge of finding a substantial number of marketable projects. As of now, only a handful of Uzbekistan's universities and research organizations are able or currently aim to generate commercially feasible technology-based products and start-ups. However, there are significant risks for external investors due to the potentially complex nature of such partnerships. In these STI parks, four traditional outcomes of technology or knowledge transfer are commonly used: patent applications, research agreements, licensing deals and the establishment of start-ups. Evaluating the existing STI parks by applying these criteria would show that their main focus is not on upstream R&D activities. Instead, they serve as hubs for domestic innovators operating across various technology levels, unified by their focus on import substitution requirements. The outlook is more promising in the medium term for digital high-tech start-ups, which face lower entry barriers into both the local and global markets, provided the talent pool of programmers continues to expand.

However, there is significant potential for alternative models, in particular in university- and industry-focused STI parks. New opportunities for developing a vibrant innovation ecosystem in the field of IT services can be supported by the growing demand for such services (including e-commerce) locally. From a macroeconomic perspective, STI Parks linked to corporate venturing are the most impactful in terms of output, employment and exports. However, their growth will be determined by the extent to which the privatisation processes proceed and the extent to which state-owned firms become more entrepreneurially driven. The emerging mode of technopark-driven free economic zones (TP-driven FEZs) is the emerging model, draws on lessons learned from traditional FEZ, particularly within natural resource-based industries where building related capabilities is more feasible. With the availability of venture capital, the goal should be to attract new technology firms as reliable suppliers and providers of knowledge-intensive services for natural resource sectors. However,

there is a risk that TP-driven FEZs may return to functioning like any other FEZ without achieving their full potential.

The success of individual STI parks is also influenced by the regulatory environment within their respective innovation ecosystems and broader institutional issues in the national innovation system. Legislative challenges include the absence of dedicated IPR courts and enforcement mechanisms, as well as unclear legislation on ownership rights of publicly funded technologies, particularly regarding remuneration for owners and inventors/authors. On the funding side, there is insufficient state support for the commercialization activities of projects within STI parks, along with a lack of financial instruments to help start-up and innovative companies establish and consolidate before scaling up. Finally, there is a lack of official statistics collected on R&D&I and collaborative R&D activities and activities of the STI parks, making evaluating their impact very challenging.

Box 4
Key messages

- Challenges include limited commercializable projects, insufficient stakeholder collaboration and a lack of specialized support for technology transfer and innovation management.
- Tackling these challenges will require a mix of targeted policy instruments, as well as stronger management capacities and additional efforts to encourage collaboration across the entire innovation ecosystem.

V.
Conclusions

Uzbekistan's STI parks are still emerging, facing the challenge of balancing commercial goals with fostering R&D. Their success hinges on closer university-industry ties, more robust policies and fostering an innovation culture to unlock the potential of the parks as engines of economic growth.

All STI parks in Uzbekistan share a common characteristic: they have been established within the last five years, a period that includes the COVID-19 pandemic. As a result, these parks are still in the early stages of their development. The managers are relatively young and have limited experience in industry or STI park management. Considering this, it is too early to determine what STI park models and parks have been successful and why. Furthermore, a relevant set of evaluation criteria needs to be defined for external evaluators as well as park managers to evaluate their activities.

This leads to the following analytical conclusions:

1. Each STI park model functions within its own innovation ecosystem, so evaluating its activities using external metrics could be somewhat complicated and challenging. The evaluation process should include a set of indicators relevant to the ecosystem the STI Park is designed to enhance. It is essential to develop a solid monitoring and evaluation framework for STI parks, ensuring that the developed framework is relevant to the innovation system.
2. The standalone STI park model has its challenges due to the innovation ecosystem (particularly in R&D activities) being somewhat weak across the country. However, there is room for both growth and improvement. Their primary constraint is a limited supply of potential commercial results of public R&D and the limited supply of local technology (non-digital) entrepreneurs. The feedback from four tenant companies within these STI parks suggests that the added value from the STI parks is perceived as minimal (aside from benefits such as below-market rent). These parks seem to have to choose between focusing on increasing occupancy (and rental income) and tax incentives or fostering technology-based businesses. Once in the market, some parks appear to favour the first option. Policies should target the inconsistency of their objectives. Policymakers need to tackle the conflicting objectives by either bringing these parks closer to universities and public R&D institutions or by encouraging and strengthening collaboration between research universities and businesses within the parks. With time, this approach could help align the standalone STI parks with the activities carried out by universities or research organizations and encourage a review of existing taxes for research and development investments. Furthermore, if privatized these STI parks could function as private entities with a focus on real estate profits.
3. STI parks that emphasize strengthening university-industry linkages should be seen as part of a broader science-industry policy, rather than being treated solely as standalone entities. A UNECE

(2022) study examined the nature of science-industry linkages in Uzbekistan and proposed several key policy recommendations. To further strengthen the innovation ecosystem in which standalone and university-focused STI parks operate, it is crucial to consider the following recommendations:

- Aim to increase the overall quality of higher education by putting in place a separate agency for quality assurance in higher education or modernizing the existing State Inspectorate for quality control of education;
- Increase research activity among university teaching staff by integrating Higher Education Institutions (HEIs) with Public Research Organizations (PROs) to inform teaching practices;
- Restructure PROs to meet the demand for innovation-related services;
- Establish R&D commercialization grants to support collaboration within the innovation system;
- Introduce a programme that would match grants for R&D projects in partnership with the private sector.

Dynamic large firms drive **innovation through strong SME linkages**

In a reformed R&D ecosystem, such developments would help shift the incentive framework, resulting in greater demand for STI parks' services.

4. Virtual IT parks operate within an innovation ecosystem where increasing local demand could be met by a growing domestic IT sector. The key question is whether this development will follow or lead the economy, in particular when it comes to the services industry. While the IT park's programmes and activities are well-designed, the quality and availability of skilled local programmers are ongoing concerns. While the government should continue enhancing the regulatory framework, addressing human resource needs will require significant changes in education programmes and stronger ties with both local and international ICT companies. Additionally, as highlighted in other international reports, cooperation across the ecosystem (finance, education and industry) needs considerable improvement.
5. Entrepreneurially dynamic large domestic firms play a crucial role in innovation ecosystems and Uzbekistan has seen several successes in this area. These businesses form part of the corporate innovation ecosystem and Uzbekistan has had a few successful cases. It is now essential to strengthen their connections with domestic suppliers and emerging technology-based firms. Competition policy might be insufficient, as the prevalent position of these companies in the local economy. Instead, additional efforts should be put in place to focus on encouraging partnerships between local SMEs and larger domestic or foreign companies. Large firms are natural partners for supporting SMEs in upgrading their technologies as part of their export strategies. Similarly, adopting this approach will require a better understanding of the barriers to supplier development and ensuring that corporate innovation systems in large firms are open to such collaboration.
6. Technopark-driven Free Economic Zone is an emerging model of STI parks. This approach aims to attract foreign direct investment (FDI) and strengthen collaboration and technology advancement among local companies through integration into global value chains. This direction is relatively new; therefore, it is still unclear how various stakeholders should collaborate to support this development better. There is also a concern that these zones might return to operating as traditional FEZs, focusing on foreign firms and ensuring sustainable finances for technopark managers. Furthermore, additional efforts will be needed to ensure improved awareness and expertise by organizing workshops for local businesses, partnering with universities to offer specialized training programs and creating online resources with best practices for technology adoption.

VI.

Promoting technoparks: Policy recommendations from the best practice

Building on best practices, recommendations include focusing on the diversification of government support on elements that go beyond infrastructure, to strengthen capacity-building for STI park managers, improving existing funding mechanisms and promoting a collaborative culture to support technology transfer and innovation management.

This section presents policy recommendations informed by best practices deemed relevant for Uzbekistan.

General Support for Technoparks

Challenge: Government support instruments often focus too much on technoparks as physical spaces rather than their activities.

A significant portion of technopark funding often goes toward building infrastructure, while key activities like fostering synergies, attracting innovative projects and developing incubation services are either sidelined or lack support altogether. This process can take years and the failure rate is relatively high. The question is whether the government should place its entire innovation policy focus on technoparks or diversify with additional innovation tools. It is crucial to expand the policy scope beyond just R&D-based growth supported by technoparks, to include broader support for firms' innovation activities, particularly in engineering, quality and productivity-enhancing services.

Recommendation: Prioritize support for innovation projects and those managing them, followed by additional support mechanisms for technoparks as organizations. Such support functions could include activities (innovation projects), people (training for technology transfer) and organizations (technoparks).

Challenge: Investments in physical infrastructure can create the illusion of effective use of funds while neglecting the primary goals of technology transfer and innovation management.

However, buildings are secondary to the main objective of the technopark: technology transfer and effective innovation management. Those on the ground have limited influence over these highly 'intangible' activities. Even when this is acknowledged, there is still a high failure rate in establishing new organizations. Building an efficient management team requires (I) monitoring and coaching of management, along with an effective early warning system for any issues and ii) a performance-driven pay structure for the technopark's

STI park's **success hinges on technology transfer**, not buildings

management team. These measures should be designed and implemented at the local level to achieve better results.

Recommendation: Focus on intangible activities such as technology transfer and innovation management. Employing this practical approach is essential to ensure the success of the technopark's key objectives. These activities would need to be monitored locally.

The key point here is to distinguish between support for technopark activities (cooperation with R&D and higher education institutions, active management of technology transfer, support for technology-intensive activities) and support for technoparks as organizations.

Operational and Management Issues

Challenge: a heavy administrative burden on the government for directly funding technoparks and incubators.

The government can reduce the existing administrative burden by offering free leases on designated areas instead of directly funding various incubators or technoparks as organizations. This approach shifts the responsibility to local administrations and private and public enterprises to take on the risk of establishing technoparks. Effective government support for technopark activities can be provided by backing innovation projects through spin-offs and implementing train-the-trainer programmes. Most importantly, the government should avoid the temptation to fund technopark facilities solely for ease of financial monitoring and should not fall into the misconception that simply grouping several small firms will automatically result in a technology park.

Recommendation: Provide free leases on designated areas for STI parks and allow local authorities and enterprises to take responsibility and assume risks associated with setting up technoparks. Support innovation projects and training programmes instead of focusing on spin-off ventures.

Challenge: Selection criteria for technopark management and operations can be seen as unclear and inconsistent.

Recommendation: The selection of candidate organizations for free leases should be based on sound business plans and their relevance to tenants' plans. Apply the following criteria (equally weighted):

- Business competence (competence criterion)
- Potential connections and links between tenants (complementarity criterion)
- Suitability of physical facilities (appropriateness criterion)
- Facilitation of academy/university-industry links (diffusion effect)
- Technology value-added effect and
- Commercialization potential (commercialization criterion)

Challenge: Government investments often fail to attract private capital and ensure the continuity of innovation processes.

Recommendation:Invest in spin-off ventures with promising market potential through the Innovation Fund. Engineers should be encouraged to join the core venture teams while ensuring that the Innovation Fund remains a minority shareholder in order to attract additional capital.

Funding and Financial Support

Challenge: How to ensure the effective use of funds and prevent misuse in technology development and capability-building activities.

Recommendation: (I) Develop a flexible grant-based subsidy mechanism through the Innovation Fund to stimulate firms' technology development activities, design and engineering work. (II) Investigate establishing a grant-based mechanism to assist firms in investing in training and capability-building for design, engineering and R&D.

Challenge: Addressing and balancing public concerns about the misuse of grant funds while supporting private-sector innovation activities.

Recommendation: Involve and contract private sector organizations as intermediaries between private sector applicants and public sector funding, ensuring both transparency and effective use of grant funds.

Infrastructure and Leasing

Challenge: Government investments in technopark facilities without ensuring effective use and synergy among tenants.

Recommendation: Provide long-term leases (20-30 years) on property to be converted into industrial/technology/ business parks but avoid direct investments in these properties. Support specific incubation programmes.

Challenge: Ensuring that business park proposals cater to the needs of different enterprise sizes and industries.

Recommendation: Business parks should be designed with SMEs in mind with smaller surface areas. Industrial and technology parks (ITP) should be located outside urban centres. Offer a broad range of customs and tax preferences and benefits for export-oriented ITPs.

Challenge: Ensuring the capability of organizations to manage and invest in leased facilities.

Recommendation: When selecting organizations for long-term leases, take into consideration their ability to invest in and manage park facilities as well as the overall economic and social impacts on local and national economies. Eligible organizations should be selected through a tender process.

Grant-based funding is **key to boosting technology development**

Capacity Building and Training

Challenge: Limited local expertise in innovation management and technology transfer.

Recommendation: Fund programmes for building capabilities in business incubation and technology business incubation. Implement programmes based on the 'train-the-trainer' model to form management teams responsible for managing innovation projects.

This should comprise of the following:

- At least 20 (optimally 50) potential trainers could be sent abroad to be trained in innovation management.
- These trainers should organize training programmes within the country, which should be undertaken within the next 2-3 years following their return.

Building local expertise in **innovation is crucial for growth**

- Trainers should form management teams, whether in R&D institutes, enterprises, universities or technoparks, which work actively on managing innovation projects selected through the Innovation Fund.

Challenge: Supporting the market for business and technology services sustainably.

Recommendation: Subsidize innovation centres for a limited period, such as a maximum of two years, to offer services to SMEs.

The following criteria for such support should be considered:

- the experience and competence of the innovation centre team (competence criterion);
- opportunities for improving the competence of the innovation centre team (opportunity criterion);
- specificity of training need – general project management knowledge vs technology or area-specific knowledge (technical criterion); and
- number of areas (finance, marketing, innovation management) of support (degree of comprehensiveness criterion).

The proposed subsidy of 50 to 80 per cent of the salary (for a limited number of employees) is expected to result in significant benefits. These benefits should be linked to a programme of activities with a solid training component, which could help generate enthusiasm about the potential positive impact.

Challenge: Supporting Gender Inclusivity in Uzbekistan's STI Parks.

Recommendation: Promote gender diversity in STI park leadership and management. Support female entrepreneurship and participation in startups. Address barriers to participation in STI education and career paths. Mainstream gender perspectives in STI policy developments. Encourage women's networks and peer support groups.

The following measures should be considered:

- Ensure that all policies related to STI parks and innovation are developed through a gender lens and take into account the unique challenges faced by women in the sector;
- Implement gender-sensitive policies within STI parks, including flexible working conditions and family support to help establish an environment conducive to women's participation in STI park management and entrepreneurial activities;
- Encourage recruiting of women in leadership and managerial roles within STI parks to ensure diverse perspectives and decision-making;
- Develop targeted support programmes for women entrepreneurs, providing access to funding, training, mentorship and networking opportunities;
- Establish financial incentives aimed specifically at female-led startups to encourage greater participation in the STI sector; and
- Create awareness campaigns and outreach programmes to encourage more women to take up careers in STEM fields and entrepreneurship, starting from educational institutions to professional development stages.

Challenge: Supporting Disability Inclusivity in Uzbekistan's STI Parks.

Recommendation: Address barriers to participation of persons with disability in STI education and career paths. Put in place dedicated funding and support programmes and ensure STI parks are designed and adapted to make these accessible to everyone.

The following measures should be considered:

- Establish financial programmes aimed at supporting entrepreneurs with disabilities and take into account the unique challenges faced by individuals with disabilities in the sector;
- Design and adapt where necessary STI parks based on the principle of universal access and in line with international standards for accessibility;
- Develop targeted support programmes for entrepreneurs with disabilities, providing access to funding, training, mentorship, and networking opportunities tailored to their needs and experiences;
- Develop new and extend existing digital literacy programmes for disabled individuals to help them take part in the digital economy;
- Foster the development of networks of entrepreneurs with disabilities to enable peer mentoring, knowledge-sharing and community support between persons with disabilities, researchers and professionals; and
- Create mentorship programmes that connect disabled entrepreneurs with key actors in the STI ecosystem.

Broaden the scope of innovation policy: from support to STI Parks towards widening the base of the innovation active enterprises

Challenge: Supporting the development of new technology-based businesses via technoparks is demanding, with high failure rates and substantial reliance on entrepreneurs and external factors. This support requires broadening the scope of innovation policy and related instruments by increasing the base of innovation-active enterprises.

Recommendation: The innovation policy should target instruments and measures that go beyond STI parks. This broadening of innovation policy instruments should include support for businesses' innovation activities, particularly in the fields of technology, quality and productivity-enhancing services.

It is essential to conduct a study to assess the feasibility of a simplified and flexible grant-based subsidy mechanism. Such a subsidy mechanism could help encourage businesses to engage in technology development activities, particularly design and engineering work that might not fit otherwise under R&D eligibility criteria. The Innovation Fund needs to implement such a grant-based approach, as it would allow for greater technological development within firms. Over time, or after completing a certain number of projects, these firms would likely become eligible for public R&D funding, representing a key milestone in their innovation process.

Alongside this study, a second investigation should explore the possibility of creating a flexible grant-based mechanism to support firms investing in training and capacity-building activities aimed at enhancing their workforce for design, engineering and R&D roles. This could offer incentives for individuals in R&D institutes to transition into firms. The investigation would consider (a) direct training initiatives, (b) design and engineering projects with significant training and learning components and (c) subsidies for R&D-related positions within the industry for a set duration. It would also look at ways to encourage investment in these activities by both individual firms and groups of enterprises with shared interests.

Broaden innovation policy **to support wider business development**

Box 5
Key messages

- Effective support for technoparks should go beyond just infrastructure investments. It should prioritize innovation activities and capacity building.
- The government needs to facilitate conditions for technoparks by offering free leases while supporting innovation projects and capability-building programmes.
- Government policies should offer strategic support and incentives to encourage the development of innovation ecosystems.

VII.

Promoting technoparks: Policy recommendations from experiences in Uzbekistan and China

Drawing from experiences in Uzbekistan and China, the report suggests creating online platforms for collaboration, establishing R&D hubs with accredited labs, developing clearer policies for technology transfer and using blockchain for transparent funding allocation.

The recommendations below have emerged from the experiences in Uzbekistan and China and reflect discussions among the stakeholders involved in supporting technoparks. They complement the above recommendations that arise from the world's best practices and address the immediate concerns of stakeholders in Uzbekistan's innovation system. They are designed to address specific challenges within Uzbekistan's innovation ecosystem, enhancing connectivity, infrastructure, regulatory support, professional standards, transparency and funding for technology transfer and commercialization.

Establish Matchmaking Online Platform like the Hubei Sci-tech Innovation Supply Chain Platform in China

Challenge: Lack of Connectivity and Collaboration. There is a significant gap in connecting researchers, innovators and businesses, leading to fragmented innovation efforts and missed opportunities for collaboration.

Recommendation: Establish a Matchmaking Online Platform like the Hubei Sci-tech Innovation Supply Chain Platform in China.[7] This platform could further enhance the levels of connectivity by supporting and encouraging networking and collaboration among researchers, innovators and businesses.

Create an R&D Hub with Internationally Accredited Laboratory

Challenge: Insufficient Research Infrastructure. There is a lack of advanced research facilities and accredited laboratories to support high-quality research and

[7] Established in June 2023, the Hubei Sci-tech Innovation Supply Chain Platform has formed a demand-oriented and enterprise-centered industrial innovation ecosystem. It efficiently connects industry, academia, research and technological application through this platform, effectively sharing risks of investment in innovation between government and enterprises.

development in key sectors such as agriculture, textile, mining and biology.

Recommendation: Create an R&D Hub with an Internationally Accredited Laboratory. This hub will offer modern research facilities, supporting innovation and high-quality research in critical sectors.

Issue Research Commercialization and Technology Transfer Law

Challenge: Regulatory Gaps in Technology Transfer. The current legal framework does not comprehensively support the commercialization of research and innovation as it does not cover the entire technology transfer supply chain.

Recommendation: Issue Research Commercialization and Technology Transfer Law: This legislation will help ensure a cohesive and supportive environment for technology transfer and commercialization by regulating spin-offs, start-ups, business incubators, venture capital and other stakeholders.

Establish A Technology Transfer Manager Certificate

Boost collaboration with **matchmaking platforms and R&D hubs**

Challenge: Lack of Professional Standards in Technology Transfer. There is a clear need for standardized qualifications and certifications for technology transfer professionals. Addressing this need will help ensure effective management and participation in innovation initiatives.

Recommendation: Establish a Technology Transfer Manager Certification programme in Uzbekistan. Such a certification programme can help standardize qualifications for technology transfer managers nationally. It would also further improve professional standards and involvement by allowing certificate holders, including government officials, to take part in Innovation Fund calls.

Integrate Blockchain and AI Technologies into Innovation Fund Calls Online Platform

Challenge: Lack of Transparency and Traceability in Grant Allocation. The current process for allocating government grants could benefit from more transparency and traceability, leading to less inefficiencies and mistrust.

Recommendation: Ensure a more efficient and trustworthy grant allocation process by integrating Blockchain and AI Technologies. The use of blockchain and AI technologies will help enhance the transparency and traceability of government grants.

Establish a Separate Technology Transfer and Commercial Fund

Challenge: Inadequate Funding for Technology Transfer and Commercialization. There is a need for dedicated support funds for the technology transfer and commercialization processes.

Recommendation: Establishing a separate Technology Transfer and Commercial Fund under the National Office for Innovation and Technology Transfer of Uzbekistan will provide targeted financial support for technology transfer and commercialization initiatives, reducing the funding gap.

VIII.

Training needs: Specific suggestions for organizing training programmes

Training programmes for STI park managers need to focus on technology management, developing innovation ecosystems and hands-on skills such as product development and financing innovation. Developing tailored modules will help address the specific challenges faced by different park models in Uzbekistan.

Diversity of Challenges Faced by STI Parks

Challenge: All STI parks are still in the stage of early experiences and intensive 'learning by doing.' The issues faced by different STI parks, such as 'Ohangaron Tech Industrial,' Youth Technology Park and Virtual IT Park, differ significantly. This diversity makes designing a comprehensive training programme complex.

Recommendation: Develop a training programme that provides the basics of technology management and management of innovation ecosystems. Tailor the programme to address the specific challenges of different STI park models by incorporating flexible modules that can be selected based on the profile of the participants.

Training Modules for STI Park Managers

Challenge: STI park managers need to help startups develop technology-based businesses and be familiar with the related issues. Special training is needed in developing new products and services, creating new ventures, building an innovation organization, managing R&D projects, financing innovation projects and managing IPR.

Recommendation: Select modules depending on the profile of the participants to ensure relevance and applicability from the following modules:

1. Managing new products and services development
2. Creating new ventures and building the innovation organization
3. Managing R&D projects
4. Financing innovation projects and
5. IPR management

Tailored training equips STI park **managers for innovation success**

Best Practices and Real-World Experiences

Challenge: STI park managers require further expertise in good practices and real-world experiences to manage the parks effectively.

Recommendation: Organize educational and training sessions led by experts on managing STI parks, sharing good practices informed by real-world cases. These sessions should provide practical lessons learned from such successful cases.

National Innovation Systems and Ecosystem Management

M&E system and **active learning vital for STI park growth**

Challenge: There is a need for a comprehensive understanding of technology strategy and management issues at the innovation ecosystem and national level.

Recommendation: Include modules on:

1. National innovation systems and entrepreneurship
2. Innovation ecosystems with application to the ICT ecosystem
3. Innovation networks and open innovation
4. Review of innovation policy instruments and
5. Innovation indicators

Monitoring and Evaluation (M&E) System

Challenge: Uzbekistan STI parks will need to be evaluated in a few years, but no established in-depth Monitoring & Evaluation (M&E) system currently exists.

Recommendation: Include a survey of methodologies of M&E methods in the training programme, with a particular emphasis on:

1. Methods for assessing industry-science links
2. Evaluating R&D and innovation programmes and
3. Evaluating R&D organizations

Active Learning and Exchange of Experiences

Challenge: Learning is never passive and requires actively exchanging findings, opinions and experiences.

Recommendation: Require participants to come prepared with a presentation in their area of expertise or their own tasks. Have participants present to each other to foster a constructive but critical exchange of views. This approach ensures active engagement and deeper absorption of the learning material.

ANNEX
Selected Cases of STI Parks in Different Economies

The role of Science and Technology (S&T) parks in fostering innovation and economic growth has been widely studied and debated globally. This annex draws on various case studies and research findings, which could generally be of helpful reference to Uzbekistan.

This overview underscores that while S&T parks can be crucial in promoting business incubation and technology transfer, their effectiveness in driving innovation and economic diversification varies widely. Key factors influencing their success include the quality of linkages with universities and research institutions, the presence of highly skilled labour, the entrepreneurial orientation of SMEs as well as specific policies and incentives designed to foster R&D and innovation.

Kazakhstan's Technoparks

A study on Kazakhstan's technoparks (Radosevic and Myrzakhmet, 2009) concludes that technopark firms are no more innovative than other firms. They are oriented mainly towards the local market and operate in traditional sectors; the frequency and intensity of their external links are more developed than those of their internal links. The critical motivations for relocating to a technopark are lower rents and the possibility of accessing finance. Overall, Kazakh technoparks seem to be successful in facilitating business incubation but much less so in terms of innovation promotion and diversification of the economy.

EU Business Incubators

The first comprehensive analysis of EU business incubators by the Centre for Strategy & Evaluation Services (2002) has shown that:

- While many incubators can recoup costs (40 per cent) from tenants, the public subsidy was still very high (60 per cent).
- There are four critical areas of value added by business incubators: training of entrepreneurs (often in the pre-incubation stage), business advice, financial support (usually through links with an external provider) and technology support.
- One of the critical problems of incubators is maintaining a balance between high occupancy rate and selective admission, such as ensuring clustering and networking.

UK and Australian Science Parks

Westhead and Storey (1995) surveyed 35 UK science parks. They found that the probability of a firm surviving was higher if it had a link with a university. Thus, they argue that the role of science parks in the UK may be a critical factor in the survival of high-tech small firms. Philimore (1999) evaluates the Western Australian Technology Park (WATP), using the interactions of in-park firms as a criterion. He finds that the companies located in the WATP usually form networks and he considers this interaction to be significant.

In successful cases, incubators contribute to their tenants' growth and survival, making the park a viable system for nurturing new technology-based firms. According to one survey, almost all incubator services are used to some degree, with nearly half of the firms in the survey assigning a significant

value to office services (Mian, 1996). However, business assistance services are not used frequently; a total of 45 per cent of the firms never used seven of the eight available services. However, over two-thirds, or 67 per cent of the respondents used business plan assistance at inception.

Hsinchu Science-based Industrial Park

Hsinchu Science-based Industrial Park is a well-explored success story in Taiwan, Province of China (Xue, 1997). Among its most distinctive features are:

- Most facilities in these parks are standard factory buildings leased out to industrial investors to help small and medium-sized enterprises (SMEs).
- Unlike most other science parks worldwide, where universities or government labs are the centres of R&D activities, Hsinchu STI Park has emphasized demand-motivated R&D carried out by the targeted industry. Such R&D may involve product development or process improvements articulated by demands from the market or the needs of manufacturing processes.
- Instead of trying to transfer R&D results from universities and research institutions, various incentives and programmes are set up to encourage firms in the park to increase their R&D investments and 'upgrade' their R&D activities from limited improvements to imported products or processes to new products and process development.

Hence, Hsinchu STI Park is a case of enterprise-driven and demand-led innovation-based growth, which was possible due to several unique factors existing simultaneously (Xue, 1997):

- Ample supply of highly skilled labour from two technically oriented universities,
- Ample supply of interested, entrepreneurially oriented SMEs,
- The ability of the park administration to act as a gatekeeper in ensuring the selection of only technology-based companies that fit the targeted industry, investment policy geared towards knowledge-intensive industries,
- Targeting industries that have arrived at a level where they need upgrading to the R&D and knowledge-intensive stage of development so that it brings with it articulated demand for their R&D and
- The crucial role of Industrial Technology Research (ITRI), a government institute concerned with industrial R&D, is to develop innovative technologies for establishing high-tech industries and integrate relevant technologies to improve manufacturing processes and product quality for existing industries.

The case of Hsinchu STI Park shows the significance of the external factors and drivers that form the economy's ecosystem. Also, unlike the idealized models of STI parks, which are technology push or commercialization R&D driven, Hsinchu STI Park was based very much on downstream R&D and manufacturing activities.

China's STI Parks

Chinese parks are among the most recent and prominent cases of successful technology upgrading. The Chinese case is often considered unique due to the country's size, efficiency in organization and mobilization and global significance.

The most noticeable feature of the Chinese STI parks is that they have been oriented to 'the wholesale importation of foreign technology, in the form of inward investment, as opposed to promotion of indigenous firms and technologies via institutional reform' (Sutherland, 2005). In 2000, a quarter of China's industrial output growth originated from 53 trial high-tech parks and two-thirds of all high-tech exports (ibid). The export value of products from 54 high-tech zones as a percentage of China's total exports from 2006 to 2016 almost doubled from 15 per cent in 2006 to 28 per cent in

2016 (Walcott, 2021). Econometric evidence on the impact of STI parks shows that the settled initially companies will significantly increase R&D investments while in STPs. Still, firms outside the park will also increase R&D investments due to pressure from firms in the same industry (Xue and Zhao, 2023). These effects are significantly higher in highly competitive industries, which suggests that STPs drive the industry through the competition in the product market.

In earlier periods, before China reached the present level of development, the selection of firms in STI parks did not conform to the definition of what constituted a 'high-tech' product. Their success reflected the country's policies that were concerned with promoting production rather than STI parks being engines of innovative development. The original target to nurture technological development in indigenous Chinese corporations had evolved into the strategy of direct transfer of technology via foreign direct investments (FDI). Through their highly favourable policies, the parks successfully attracted suitable foreign investors and technologies for export-oriented production in large-scale plants. The second purpose of the parks was to promote dozens of innovation centres that had advanced at a much lower pace. They had not become 'zones/clusters of innovation and co-operation among R&D, industry and education.' The links between parks, research and learning centres have developed much less (Sutherland, 2005). The flow of patents granted based on indigenous research in these parks that lead to marketable transfers remained relatively modest (Walcott, 2021).

Based on a mix of local and foreign investments, the Chinese science and high technology park model has been changing recently. There is a trend of new companies forming based on domestic efforts and the role of universities in nurturing native companies through information networks and entrepreneurship training. There is a shift towards endogenous technological efforts (Walcott, 2021). In this new stage, new challenges will arise. For example, econometric evidence shows that technology business incubators (TBI) do not accelerate economic convergence nationwide among Chinese regions. However, non-state-owned and specialized TBIs can speed the converging process, while state-owned and diversified TBIs do not influence regional economic convergence (Hong et al., 2017).

Box 6
Key messages

The international experiences of STI parks provide valuable lessons for Uzbekistan. Successful STI parks require infrastructure, effective management, strong linkages with academia, tailored policies and a focus on local and global innovation dynamics. Understanding these factors can help shape effective strategies for developing Uzbekistan's own S&T parks and innovation ecosystem.

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