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# Strengthening The Role of Science and Technology Parks on The Development of The Textile Industry of Uzbekistan

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**Abstract:** With the increasing influence of globalization and rapid technological progress, innovative infrastructure emerges as a critical driver for boosting the productivity and expansion of various sectors. This study focuses on evaluating the influence of innovative infrastructure on Uzbekistan's textile industry while exploring strategies to enhance its efficiency. The research examines ongoing infrastructure initiatives, highlights key challenges, and suggests practical measures to maximize the impact of innovation in this field. Employing a mixed methods approach that integrates both qualitative and quantitative analysis, this paper aims to deliver an in-depth perspective on how innovative infrastructure can stimulate growth, enhance competitiveness, and promote sustainable development within Uzbekistan's textile sector. The outcomes of this research will provide meaningful guidance for policymakers, industry professionals, and academics engaged in innovation and industrial advancement.

**Keywords:** Innovation, Manufacturing, Science And Technology Parks, Uzbekistan, Industry, Competitiveness, Textile

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## 1. Introduction

Uzbekistan's textile industry serves as a vital pillar of the national economy, significantly driving job creation and contributing to export earnings. With a longstanding tradition in textile manufacturing, the country holds a notable position in the global market. Nevertheless, maintaining and advancing this competitive advantage necessitates greater emphasis on fostering innovative infrastructure within the sector.

Innovative infrastructure encompasses the structures and systems that enable the adoption of advanced technologies, streamlined processes, and sustainable operations. It includes modernized production facilities, state-of-the-art machinery, efficient supply chain mechanisms, and robust research and development (R&D) centers. For the textile industry, innovative infrastructure can lead to enhanced productivity, reduced production costs, improved quality of products, and a stronger presence in international markets [1], [2].

In Uzbekistan it is very crucial to make the enterprises especially textile industry competitive through introducing innovations as it is keeping the policy of entering the WTO. The textile industry has a very big potential in the country as almost all raw materials are being produced within a country while there is lag in processing.

This research paper aims to analyze the current state of innovative infrastructure, identifying key areas that require development and improvement. Therefore, the present

study highlights that through identifying current challenges and proposing some solutions, innovative infrastructure can play an important role in the contribution of the industry to the development of the national economy. The thesis of the study is that the effective creation and introduction of innovative infrastructure will noticeably increase the efficiency and competitiveness of the textile industry of Uzbekistan [3]. Next step is to determine the significance and potential effectiveness of new infrastructures, such as Science and Technology Parks (STPs), incubators, and innovation hubs in advancing technological accomplishment and moral economic development. In particular, the study investigates their macroeconomic and microeconomic effects, including contributions to job creation, ability to attract research endeavors, influx of venture investments and boost to regional development.

In macroeconomic terms, an investigation is also made on issues related to employment created, research activity stimulated, venture capital attracted and regional development. On the microeconomic level it assesses indicators such as patent creation, ties with research institutions, and creation of specialized employment. This study underscores the multiple objectives redesigning these infrastructures and the need for a multi-faceted evaluation of performance that transcends traditional quantitative success indicators such as the creation of patents, attraction of investments and any structural set-up conducive to territorial integration.

The evaluation and management of the performance of these infrastructures was carried out using Key Performance Indicators alongside the Balanced Scorecard Framework as this research shows. The method is BSC, which assesses the business from several metrics, such as financial, customer, internal processes, as well as learning and development. With the help of these tools, the effectiveness of Science and Technology Parks (STPs), incubators and innovation hubs in supporting start-ups, researchers and established enterprises, so as to enhance technical advancement and innovation is examined in this study.

This study provides an analysis of Uzbekistan's science and technology statistics for the last five years and focuses on the vital innovative infrastructures necessary in the creation of a robust innovation ecosystem. The results are designed to assist decision makers in the effective management of these infrastructures to further optimally harness them for economic and technological advancement.

While there is an increasing amount of literature on this topic, a systematic review has yet to be done. This article attempts to fill this gap by providing an in depth analysis of the available literature on the systemic and process oriented approaches that have been used in teaching economic disciplines.

## **2. Materials and Methods**

This study takes a multimethod approach to assess innovation infrastructures, drawing on both qualitative and quantitative methodologies. The data was collected from a mix of primary sources, including surveys, interviews, and field observations with the managers, tenants, and stakeholders of Science and Technology Parks (STPs), incubators, and innovation centers, and secondary sources, including official documents and academic literature. The eligibility framework is based on KPIs and BSC and four dimensions – financial results, customer satisfaction, internal processes, and learning and development opportunities. These include statistical assessments and normalization of KPI data for quantitative techniques but will also include topical analyses and case study explorations for qualitative evaluations. International benchmarking serves as a compulsory assurance of result reliability, supplemented by triangulation and peer reviews. The methodology intends to create an added value in terms of improving strategic

management practices and exploring innovative infrastructures as avenues for technological innovation and economic growth.

### 3. Results

Science and Technology Parks (STPs), incubators, innovation hubs and other innovative infrastructures play a critical role in driving technological progress and economic growth. Understanding their essential role in promoting environments conducive to innovation by providing start-ups, researchers, and established businesses with key resources, support services, and collaborative opportunities is evidenced by research [4].

Science and Technology Parks (STPs) play an important role in fostering regional economic growth by developing technology-driven businesses and supporting collaborative research and development projects, as proved by Link and Scott [5] in their paper. At the same time, Phan, Siegel, and Wright [6] also highlighted the importance of incubators and innovation hubs in providing financial resources, mentorship, and networking opportunities that are vital for nurturing and sustaining start-ups.

Efficiency evaluation model The Balanced Scorecard (BSC) which is introduced by Kaplan and Norton in [7], has become a widely used system for evaluating and managing for various organizations, including innovative infrastructures. By introducing both financial and non-financial metrics, the BSC offers a flexible approach in order to analyze and monitor an organization's performance. Thus, it becomes particularly effective for measuring the activity of innovative infrastructures. While evaluating financial performance it also assesses with metrics like customer satisfaction, internal processes, and opportunities for learning and growth.

Recent research by Kurpayanidi and Abdullaev [8] sheds light on the growing influence of innovative infrastructures in Uzbekistan's national innovation system. They proved the fact that innovative infrastructures not only just support R&D but drive-up patent registrations and contribute gradually to economic growth. Their work makes a solid base for investments in innovation activity to advance technology and make economic progress in emerging markets like Uzbekistan.

Innovative infrastructures especially STPs actively build networks at the local, national, and international levels, plan strategically, and work hard to make themselves known. These parks usually feature thoughtfully designed spaces, like incubators and innovation hubs, and they involve key stakeholders in their management. Besides that, they offer a range of valuable services, often in collaboration with nearby research and educational institutions [9]. By offering key resources, facilitating technology transfer, and fostering collaboration, STPs serve as key drivers of economic growth at both regional and national levels which is important in forming clear innovation ecosystem. This research builds on these findings by providing a detailed analysis of the performance and impact of innovative infrastructures in Uzbekistan, offering insights for policymakers and stakeholders involved in their strategic management.

Key to assessing the performance of innovative infrastructures is the fact that they ordinarily have diversified objectives [7]. It is imperative to examine performance outcomes in consequentially related terms. Ordinarily, they are expected to have increased skills in the labour force, generation of employment opportunities, increased promotion of interdisciplinary R&D, an opportunity to attract investments, promotion of regional integration, and a shift to an innovation-driven economy.

Among the critical success indicators is the ability of tenants to generate patents, which represents incubator's ability to breed talent and provide a basis for creativity in innovative infrastructures. In general, patents, trademarks, and designs are documented tools that give SMEs, start-ups, and innovators protection of their creative efforts for

maximum gain and operational sustainability. However, despite the criticality of patents in capturing commercial returns from innovation efforts, they fundamentally fail to capture the aggregate performance of innovative infrastructures [10]. At the same time, in countries moving towards a knowledge-based economy, STPs also substantially facilitate other types of IPRs-protected patent filings, such as industrial design, copyright, and trademarks. Despite this, the number of applications may not be a good indicator in and of itself of the success of the research and development activity of an organization from a comparative point of view, even inside an industry. These indicators can vary, depending on the technopark goals (Table. 1).

**Figure 1.** Key Performance Indicators (KPIs) for innovative infrastructures

Category	Input Indicators	Output Indicators	Impact Indicators
Area	Qualified staff	Generated qualified workers	Economic development
Residents	Number of Residents	Number of products produced by the residents	Export share
Residents	Number of residents transformed to large industry	Technology transfer	Industry structural change
Financial	Yearly income	Partnership	Wage increases of STP workforce compared to national wages
Services	Provided services	High-tech products	Service satisfaction and retention rates
Investment	Total investment in R&D	Number of patents filed	Long-term sustainability and growth
Staff	Number of staff employed	Staff development programs	Improved workforce skills

After determining all the indicators KPI for innovative infrastructures can be calculated as follows:

$$S_{KPI} = \frac{1}{n} \left( \sum_{i=1}^n \frac{K_i}{Max(K_i)} \right) \times 100$$

Wheres:

- n - total number of KPIs
- $K_i$  be the i-th KPI normalized by its maximum possible value

Performance measures or indicators are an internal management tool with which the function of the Science and Technology Park (STP) is controlled. If the monitoring is regular, it provides evidence of progress and achievements compared to the set goal. On the other hand, evaluations require the presence of independent parties to assess the impact of the park. For instance, the valuation of a park requires interviews and on-the-spot surveys so that all the positive spillovers proven are directly linked to the park's functioning. For instance, the complexity at hand lets objective evaluation recognize that more positive changes than those that would have occurred without the conditions within the park, for example, an addition of jobs that came about because a company relocated to the park, should be placed upon the map. In short, monitoring provides value to the decision-makers with the information required for adjusting and refining the strategies of the park, while on the other hand, evaluation is a basic need for the determination of how an STP performs relative to its initial purpose and outcomes.

Major successful STPs share the following common factors: well-developed connections with the networks at all levels, robust strategies, and a proactive approach toward visibility, nationally and internationally. They also boast of well-designed buildings, incubators, and innovation spaces. These STPs also have an operational ownership and governance structure in which all critical stakeholders are involved, and a clear division of responsibilities and competence is found. They also offer a solid portfolio of value-added services, often operated in partnership with nearby academic research centers and related entities.

The Balanced Scorecard (BSC) framework is particularly applicable for measuring and managing the performance of innovative infrastructures, such as the Science and Technology Parks (STPs). Here, the BSC offers a formal approach for aligning the objectives of innovative infrastructures with more significant strategic objectives; it encompasses multiple dimensions of performance. Regarding the STPs, the Financial perspective could consider measurements such as funding generations, invested in R&D, and financial returns received from the spawned firms. The Customer perspective would be related to the delight and success of clients and partners, the appeal to new business, and the extent of workings with academic and research institutes. Further, in this BSC frame, the perspective of Internal Business Processes for innovative infrastructures would address efficiency in innovation processes, technology transfer activities, and effectiveness in providing support services to companies hosted in the infrastructures. Finally, the perspective of Learning and Growth will address the development of human capital: first, whether there are programs for training researchers and entrepreneurs and their quality; second, whether a culture of innovation is being inculcated, and third, if there are any improvements in making knowledge management systems. Management of the innovative infrastructures, by applying the BSC, would also ensure that these entities clear the immediate operational goals and contribute to long-run regional economic development via technological advancement and the creation of sustainable innovation ecosystems (Table 2.).

**Table 2.** Balanced Scorecard (BSC) Indicators for Innovative Infrastructure.

Perspective	Input Indicators	Output Indicators	Impact Indicators
Financial	- Total investment in R&D	- Revenue growth of resident companies	- Return on investment
	- Amount of funding acquired	- Increase in funding for projects	- Financial sustainability of resident companies
	- Operational costs	- Cost efficiency	- Long-term financial viability
Customer	- Number of tenants and partners	- Satisfaction levels of tenants and partners	- Retention and growth of tenants and partners
	- Quality of tenant facilities	- Number of new businesses attracted	- Enhanced collaboration with academic and research institutions
Internal Business Processes	- Support services offered	- Success rate of tenant companies	- Increased regional business activity
	- Efficiency of innovation processes	- Number of technology transfer agreements	- Effectiveness of internal support services
	- Quality of incubation programs	- Speed and efficiency of innovation processes	- Increased rate of successful innovation
	- Internal resource allocation	- Number of patents generated	- Improved technology transfer

<b>Learning and Growth</b>	- Quality and availability of training programs	- Participation rates in training programs	- Development of human capital
	- Investment in employee development	- Increase in employee skills and competencies	- Strengthened knowledge management systems
	- Support for research and development activities	- Number of collaborative research projects	- Fostering a culture of innovation

After determining all the indicators Balanced Scorecard (BSC) can be calculated as follows:

$$S_{BSC} = \frac{1}{n + m + p + q} \left( \sum_{i=1}^n \frac{F_i}{Max(F_i)} + \sum_{j=1}^m \frac{C_j}{Max(C_j)} + \sum_{k=1}^p \frac{P_k}{Max(P_k)} + \sum_{l=1}^q \frac{L_l}{Max(L_l)} \right) \times 100$$

Wheres:

- n - total number of Financial KPIs
- m - total number of Customer KPIs
- p - total number of Internal Processes KPIs
- q - total number of Learning and Growth KPIs
- $F_i$  - the i-th Financial KPI normalized by its maximum possible value
- $C_j$  - be the j-th Customer KPI normalized by its maximum possible value
- $P_k$  - be the k-th Internal Process KPI normalized by its maximum possible value
- $L_l$  - be the l-th Learning and Growth KPI normalized by its maximum possible value

Some of these innovative infrastructures include the Science and Technology Parks, incubators, and innovation hubs, which provide indispensable resources, support, and networking as part of the many ways to nurture an innovative ecosystem between startups, researchers, and established companies. Increased patent filings and raised spending on research and development, for instance, are direct indicators of the type of research environment facilitated by these infrastructures. In addition, state-of-the-art laboratories, co-working spaces, and fabricating facilities attract top talent and firms to raise the quality bar of innovation [11].

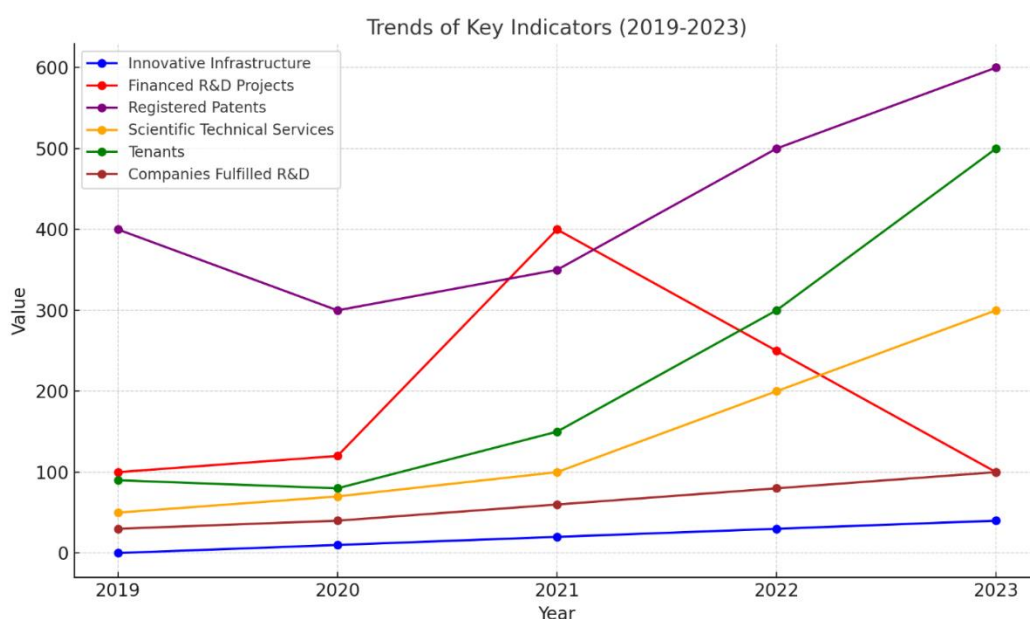
These infrastructures have a huge economic impact by being the cornerstones of job creation and supporting the national GDP. In this regard, STPs and incubators work by creating jobs indirectly through their startups and drawing other businesses towards them. Also, the quality of entrepreneurial support can be shown by the success rate at which the startup can graduate from the incubator and that the venture capitalists and other funding sources become available. This economic activity will fuel growth in that innovative ecosystem and yet create ripples in the economy by propelling technological advancements and economic development forward [5].

It is, therefore, crucial that innovative infrastructures are collaborative and networked. The collaborations between avowed players create international partnerships that will help in generating border innovation and reshuffling of knowledge, always crucial in improving or maintaining position on the global platform. The regular events, workshops, and seminars promote a lot in terms of continuous learning and networking for the development of the community. Moreover, working with local communities

ensures that innovation activities are widely accepted and the structures resulting from them are sustainable resulting in a robust and inclusive innovation landscape [12].

Finally, their care for sustainability and social impact attests to their seriousness in addressing global challenges. Green technologies are developed in so many ways, and the encouragement of social entrepreneurship leads to innovations in dealing with both environmental and societal issues. Support for the creation of those new technologies is brought about by innovative infrastructures that drive both economic and technological growth, which are necessary for an equitable, sustainable future. STPs, incubators, and innovation hubs provide a mechanism by which, through their multifaceted impact, innovation can be driven toward economic development and future technological progress [6].

In research we took indicators in science and technology sphere of the Republic of Uzbekistan last five years, which can prove the importance of innovative infrastructures in boosting development of innovative ecosystem (Fig. 1).



**Figure 1.** Selected indicators of Innovative ecosystem (2019-2023).

Innovative infrastructures include Science and Technology Parks, incubators, and innovation hubs that provide essential resources, facilities, and support services to startups and established companies [13]. The steady increase in the number of innovative infrastructures from 3 in 2019 to 45 in 2023 reflects a significant investment in creating environments that foster innovation and technological advancement.

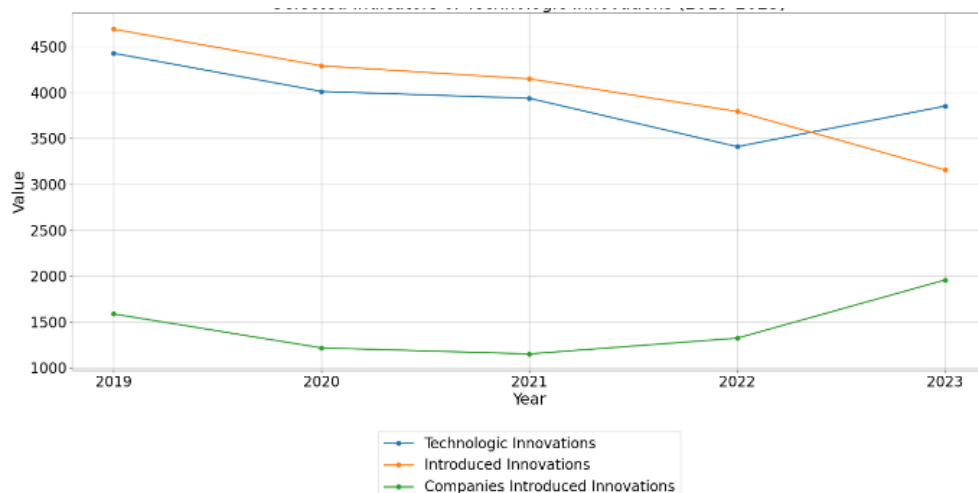
The substantial increase in the number of tenants indicates a growing demand for the services and opportunities provided by innovative infrastructures. This rise suggests that more businesses are leveraging these environments to access resources, tax and custom incentives, collaborate with other innovators, and drive their technological developments.

The number of companies involved in R&D activities exhibits some fluctuations; however, the overall trend is positive. This suggests that innovative infrastructures play a key role in supporting research and development, which is essential for driving technological advancement and fostering innovation.

Variations in the number of funded R&D projects reflect fluctuations in available financing; however, the consistently high number of projects annually demonstrates a

strong dedication to fostering R&D efforts. Such financial backing is vital for the advancement and market introduction of innovative technologies. The rise in patent registrations reflects the success of innovative infrastructures in encouraging and safeguarding intellectual property. This upward trend indicates a thriving environment for innovation and creativity, with a growing number of ideas and inventions being officially recognized and protected.

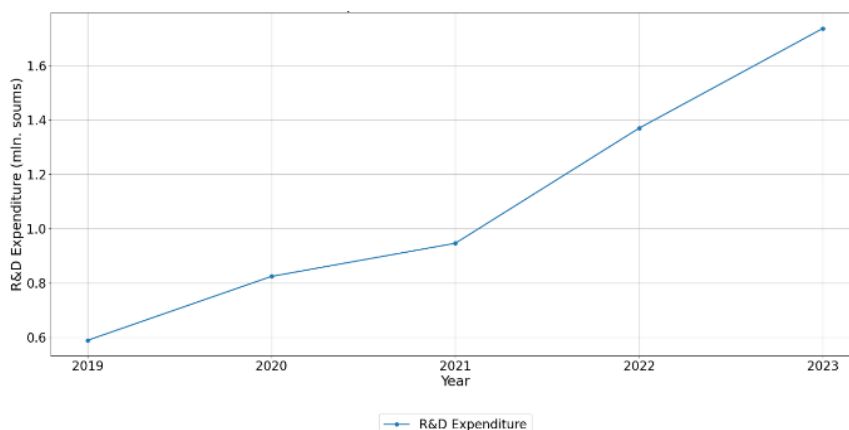
The growth in the number of organizations engaged in scientific and technical services reflects strengthened support for these essential activities. Such backing is vital for sustaining a dynamic innovation ecosystem, where technical services are instrumental in advancing and applying new innovations (Fig. 2).



**Figure 2.** Indicators of Technologic innovations of Uzbekistan (2019-2023).

Although there are fluctuations, the number of technological innovations remains considerable, demonstrating the sustained innovation efforts supported by these infrastructures. This underscores their effectiveness in fostering creativity and advancing technology. Despite a decrease in newly introduced innovations, the consistent presence of a notable number of innovations indicates that innovation activities are ongoing.

Innovative infrastructures play a crucial role in providing the necessary support and environment for bringing these innovations to market [14]. The significant increase in the number of companies introducing innovations from 2021 to 2023 suggests a positive trend where more businesses are successfully implementing new ideas and technologies. This reflects the supportive role of innovative infrastructures in fostering a culture of innovation.



**Figure 3.** R&D expenditure (mln. soums) (2019-2023).

The significant increase in R&D expenditure from 589.58 million soums in 2019 to 1,736.91 million soums in 2023 demonstrates a growing investment in research and development activities. This financial commitment is essential for fostering innovation, developing new technologies, and maintaining a competitive edge in the global market (figure 3).

#### 4. Discussion

Innovative infrastructures such as Science and Technology Parks (STPs), incubators, and innovation hubs play a pivotal role in fostering innovation across various sectors of the economy [15], [16]. By having efficient management system their impact is evident at both macroeconomic and microeconomic levels, as they drive employment generation, attract research activities, facilitate technology transfer, and promote regional development. These infrastructures support local businesses, enable technology transfer, and promote industrial collaboration, thereby forming an essential part of the advancement of a knowledge economy.

The textile industry, like many other sectors, stands to benefit significantly from the presence of innovative infrastructures. Utilizing these infrastructures allows the textile industry to strengthen its research and development activities, promote collaboration with academic and research organizations, and elevate the quality and competitiveness of its products. Advancements such as patent generation, technology transfer agreements, and increased R&D investment within the sector can drive significant economic growth and technological progress, securing the industry's ongoing innovation and competitiveness on a global scale (Table 3).

**Table 3.** Benefits of technoparks for textile industry.

<b>Benefits</b>	<b>Description</b>
Enhanced Materials	Development of new textile materials with improved properties such as durability, sustainability, and comfort.
Advanced Technologies	Adoption of cutting-edge technologies like smart textiles, nanotechnology, and bio-fabrication.
Partnerships	Promote partnerships between textile companies, research institutions, and technology providers.
Innovation Ecosystem	Regular events, workshops, and seminars encouraging continuous learning and networking.
Incubation Programs	Providing mentorship, funding opportunities, and business development support to start-ups.
Resource Access	Access to state-of-the-art laboratories, co-working spaces, and fabricating facilities.
Patent Generation	Support for the creation and protection of intellectual property through patents, trademarks, and designs.
IPR Training	Training and resources on intellectual property rights to safeguard innovations.
Product Innovation	Development of high-tech and innovative textile products opening new markets and increasing export opportunities.
Market Access	Collaborative projects with international partners facilitating entry into global markets.
Eco-friendly Practices	Support for research in green technologies and sustainable practices reducing environmental footprint.
Social Entrepreneurship	Encouraging innovations that address both environmental and societal challenges.

Job Creation	Creating jobs directly and indirectly through start-ups and attracting related businesses.
Regional Development	Promoting regional integration and economic development, benefiting the textile industry and the broader economy.

Innovative infrastructures bring numerous advantages to the textile industry, driving progress and strengthening its global competitiveness. A significant advantage lies in advancements in material development, allowing for the creation of textiles with improved features, such as enhanced durability, sustainability, and comfort. Through these innovative infrastructures, the textile industry integrates cutting-edge technologies like smart textiles, nanotechnology, and bio-fabrication which brings to new horizons for textile production to make the production more competitive. Additionally, these infrastructures foster collaboration between textile companies, research organizations, and technology providers, promoting knowledge sharing and joint innovation. Regular events such as workshops and seminars within these ecosystems encourage ongoing learning and networking, which are critical for thriving in a fast-changing industry [17].

Innovative infrastructures also provide incubation programs that deliver mentorship, funding opportunities, and business development resources, fostering the growth of emerging textile innovators [18]. Access to cutting-edge laboratories, shared workspaces, and fabrication facilities is a key advantage, allowing companies to design and test their innovations under ideal conditions. Support for securing patents ensures intellectual property protection, cultivating an innovation-driven culture. Furthermore, training programs on intellectual property rights play a crucial role in protecting innovations within the textile industry. Introducing more high-tech into the processing fosters product innovation, which helps to increase market share both domestically and globally. Establishing a partnership with international organizations enhances global market access, while research into green technologies and sustainable practices minimizes environmental impact. Subsequently, job creation, both directly and indirectly, and contribute to regional economic growth, benefiting not only the textile sector but the broader economy as well [19].

Benefits can be quantified by the following:

$$\text{Composite benefit formula (CBS)} = \sum_{i=1}^n (B_i \times W_i)$$

Where:

- $B_i$  - Score for benefit  $i$  (e.g., on a scale of 1 to 10)
- $W_i$  - Weight for benefit  $i$  (e.g., on a scale of 0 to 1)
- $n$  - Total number of benefits

The formula helps to quantitatively assess and compare the benefits of innovative infrastructures in textile industry. Therefore it would be efficient to evaluate overall impact or effectiveness of these infrastructures in this particular industry.

In Uzbekistan, innovative infrastructures have seen remarkable growth. Their numbers jumped from just 3 in 2019 to 45 by 2023. This growth reflects significant investments and a strong focus on building sustainable innovation and technology. More companies are now engaging in R&D within these facilities, showing a clear demand for the resources and opportunities they provide. The performance of these infrastructures can be followed by using KPIs or BSCs. KPIs often help to just monitor the performance of innovative infrastructures while BSCs offers multidisciplinary approach for assessing (financial aspects, customer satisfaction, internal processes, and learning and growth)

which is useful to not only just monitor the performance but make strategic management decisions.

## 5. Conclusion

The research proves the critical role of innovative infrastructures especially Science and Technology Parks in driving the growth and competitiveness of textile industry. Expansion of these infrastructures and the rise in their residents brings to increasing demand for the resources and support they provide. Furthermore, increase in R&D activities and patent registrations demonstrates their effectiveness in promoting innovation and protecting intellectual property. BSC method has proven to be a valuable tool for evaluating the objectives of these innovative infrastructures. By providing a holistic perspective, it measures performance across key dimensions, including financial outcomes, customer satisfaction, internal processes, and learning and growth.

The textile industry gains advantages from these innovative infrastructures. They drive progress in material development, enable the introducing or transferring of advanced technologies, foster collaboration among textile companies, research and educational institutions, and technology providers.

The findings clearly demonstrate that the strategic development and effective implementation of innovative infrastructures can significantly boost the efficiency and global competitiveness of textile industry. These infrastructures play a vital role by offering essential resources, facilitating technology transfer, and promoting collaboration among key stakeholders. Subsequently, regional and national economic development can be achieved.

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