

INNOVATION SCIENCE AND TECHNOLOGY

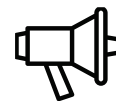


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CONTENTS

POVERTY AND DEVELOPMENT	14
Kholmirzayev Abdulhamid Khapizovich	
WAYS TO ACHIEVE ECONOMIC STABILITY THROUGH THE IMPLEMENTATION OF INNOVATIVE TECHNOLOGIES IN INDUSTRIAL ENTERPRISES	23
Sadriddinov Bakhtiyor	
STRUCTURE-PROPERTY RELATIONSHIP OF ORGANOSILICON MATERIALS: EVALUATION BASED ON THERMOGRAVIMETRIC ANALYSIS	36
Tosheva Dilfuza Farxodovna, Siddikov Ikrom Iminjonovich, Rakhimov Firuz Fazliddinovich	
"CREATING AN ALGORITHM AND SOFTWARE TOOL FOR PERSONAL IDENTIFICATION USING FACIAL SCANNING TO PROTECT THE OPERATING SYSTEM"	43
Usmonov Maxsud Tulqin o'g'li	
ENSURING INTERDISCIPLINARY INTEGRATION BASED ON MOBILE LEARNING TECHNOLOGIES.....	51
Zaripov Olimjan Kuvandiq son	
MONITORING OF THE AYDAR-ARNASAY LAKE SYSTEM AND ASSESSMENT OF THE CHEMICAL COMPOSITION OF COLLECTOR WATER INFLOWS INTO THE LAKE ECOSYSTEM.....	55
Erkabayev Furkat Ilyasovich, Madrimov Rajabboy Masharipovich, Aminov Khamza Khusanovich	
APPROBATION OF THE RESISTANCE OF BRICKS MADE FROM "ANGREN" SECONDARY KAOLIN TO THE EFFECT OF LIQUID METAL.....	62
Umurov Ulug'bek Meylievich	
THEORETICAL AND PRACTICAL FOUNDATIONS OF PERFORMANCE-BASED BUDGETING.....	68
Allakuliev Akmal Baltayevich	
IMPROVING ECONOMIC MECHANISMS THROUGH EFFECTIVE USE OF ORGANIZATIONAL AND LEGAL FRAMEWORKS IN TOURISM DEVELOPMENT.....	71
Abdusalomov Djamshid Abdusalomovich	
TEMPERATURE-RADIATION REGIME OF THE TERRITORY OF UZBEKISTAN FOR THE DESIGN OF SOLAR GREENHOUSES	76
Ilkhom Ismatovich Rakhmatov, Shakhzod Niyoz ogli Izomov	
THEORETICAL ASPECTS OF GREEN FINANCING IN FORMING A GREEN ECONOMY	81
Khalikov S. X.	
MUVAFFAQIYATLI STARTAP FAOLIYATIDA ROL O'YNOVCHI MUHIM OMILLAR VA O'ZBEKISTON SHAROITIDA STARTAP EKOTIZMINING RIVOJLANISHI.....	87
Qosimova Dilorom Sobirovna	
EFFECTIVENESS OF INNOVATION MANAGEMENT SYSTEMS.....	92
Umarova Nilufar Abdukakhorkizi	
INFLUENCE OF INTERNATIONAL RANKING ORGANIZATIONS ON HIGHER EDUCATION INSTITUTIONS AND EXISTING PLATFORMS	96
Urozboev Khayrulla Murodboy ugli	
BASE STATION MONITORING TECHNOLOGIES IN MOBILE NETWORKS	103
Ibrokhimkhujja Rikhsikhujjaev, Mohit Bhandwal	
FORMATION AND MANAGEMENT OF INVESTMENT PROJECTS OF ENTERPRISES	108
Abdunazarov Saidakhmat Abdumalikovich	
THE IMPORTANCE OF QUALITY MANAGEMENT IN ENTERPRISE ACTIVITY MANAGEMENT.....	113
Rasulov Shavkat Sharof son	
PARTICIPATORY BUDGETING OF THE STATE BUDGET	117
Khamidov Khabibullo Khikmatulla ogli	
TRANSFORMING THE HIGHER EDUCATION SECTOR THROUGH PUBLIC-PRIVATE PARTNERSHIP UNDER CONDITIONS OF DIGITALIZATION	123
Abdullayev Javohir Abdumalik og'li	
WAYS TO IMPROVE THE EFFICIENCY OF THE FINANCIAL MANAGEMENT SYSTEM IN ENTERPRISES.....	131
Begalov Sherzod Maxsutaliyevich	

DIRECTIONS FOR IMPROVING THE RESERVOIR SAFETY ASSESSMENT AND MANAGEMENT SYSTEM USING THE EXAMPLE OF THE TALIMARJON RESERVOIR.....	136
Xodjaqulova Nodira Xosiyatqul qizi	
ECONOMIC EFFICIENCY AND INNOVATIVE TRANSFORMATION PROCESSES OF DIGITAL TECHNOLOGY IMPLEMENTATION IN UZBEKISTAN'S OIL AND GAS INDUSTRY	141
Tarakhtiyeva Gulmira Kulbayevna	
INNOVATIVE APPROACHES TO RISK MANAGEMENT AND ASSESSMENT OF INVESTMENT PROJECTS IN THE DIGITAL ECONOMY.....	145
Muxitdinova Kamola Alisherovna	
INNOVATIVE COOPERATION AND MARKETING STRATEGIES FOR STRENGTHENING THE REGIONAL ECONOMY: THE CASE OF NAMANGAN REGION	149
Sattarov R. A.	
MARKETING PROBLEMS IN THE INTERNATIONAL TEXTILE MARKET AND FOREIGN EXPERIENCES IN SOLVING THEM.....	159
Musayeva Shoirazimovna	
THE PROBLEMS OF LINGUISTIC ANALYSIS OF ELLIPTICAL SENTENCES IN MODERN ENGLISH.....	165
Jurayeva Hilola Kamol qizi, Eshonkulov Ravshan Tokhirovich	
THE EFFECTIVENESS AND PROSPECTS OF INTEGRATING ARTIFICIAL INTELLIGENCE INTO URBAN SECURITY DEVELOPMENT	171
Iminov Akbarjon Odiljonovich	
21ST CENTURY CHANGES AND THE GROWING IMPORTANCE OF PROFESSIONAL ENGLISH PROFICIENCY	175
Rakhimova Shirin Utkurovna	
A COMPARATIVE STUDY OF UZBEKISTAN'S INNOVATION EFFICIENCY: EVALUATING GII OUTPUT-INPUT RATIOS RELATIVE TO LEADING AND EMERGING INNOVATIVE ECONOMIES	179
Umidjon Khoshimov	

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A COMPARATIVE STUDY OF UZBEKISTAN'S INNOVATION EFFICIENCY: EVALUATING GII OUTPUT-INPUT RATIOS RELATIVE TO LEADING AND EMERGING INNOVATIVE ECONOMIES

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Abstract: Utilizing Global Innovation Index (GII) data, this study evaluates Uzbekistan's innovation efficiency between 2020 and 2025 and compares it with top overperformers (India, Viet Nam, Morocco), regional peers (Kazakhstan, Azerbaijan), and global leaders (Switzerland, Sweden, United States). Uzbekistan's GII ranking improved to 79th in 2025, yet its innovation outputs remain significantly weaker than its inputs, resulting in an average output-input efficiency gap of -23 ranks. While Kazakhstan and Azerbaijan underperform relative to their potential, India, Viet Nam, and Morocco exceed expectations based on their input levels. The main challenge for Uzbekistan is not investment scarcity but low commercialization of research due to weak industry-science linkages and limited high-tech exports. The study concludes that Uzbekistan must strengthen national innovation system coordination, attract foreign investment, and expand sector-specific venture capital to foster an innovation-driven economy.

Key words: innovation efficiency, Global Innovation Index (GII), Uzbekistan, comparative analysis, innovation policy, R&D commercialization, national innovation system.

Annotatsiya: Ushbu tadqiqot Global Innovatsiya Indeksi (GII) ma'lumotlari asosida O'zbekistonning 2020–2025-yillardagi innovatsion samaradorligini baholaydi hamda uni yetakchi natijalarga erishayotgan davlatlar (Hindiston, Vetnam, Marokash), mintaqadagi tengdoshlar (Qozog'iston, Ozarbayjon) va global yetakchilar (Shveysariya, Shvetsiya, AQSh) bilan solishtiradi. O'zbekistonning 2025-yil holatiga ko'ra GII reytingidagi o'rni 79-pog'onagacha yaxshilangan bo'lsa-da, innovatsion natijalar innovatsion resurslarga nisbatan past bo'lib qolmoqda, ya'ni o'rtacha samaradorlik tafovuti -23 pog'onani tashkil etadi. Qozog'iston va Ozarbayjon o'z salohiyatiga nisbatan past ko'rsatkichlarga ega bo'lgan bir paytda, Hindiston, Vetnam va Marokash kirish ko'rsatkichlariga nisbatan yuqori natijalarga erishmoqda. O'zbekistondagi asosiy muammo investitsiya yetishmasligi emas, balki ilmiy ishlanmalarni tijoratlashtirish darajasining pastligi va sanoat-ilmiy hamkorlikning zaifligidir. Tadqiqot innovatsion iqtisodiyot barpo etish uchun milliy innovatsiya tizimi koordinatsiyasini kuchaytirish, xorijiy investitsiyalarni jalb qilish va tarmoqqa yo'naltirilgan venchur moliyalashtirishni kengaytirish zarurligini ta'kidlaydi.

Kalit so'zlar: innovatsion samaradorlik, Global Innovatsiya Indeksi (GII), O'zbekiston, taqqoslama tahlil, innovatsion siyosat, R&D tijoratlashtirish, milliy innovatsiya tizimi.

Аннотация: На основе данных Глобального инновационного индекса (GII) данное исследование оценивает инновационную эффективность Узбекистана в 2020–2025 годах и сравнивает её с ведущими странами-перформерами (Индия, Вьетнам, Марокко), региональными партнёрами (Казахстан, Азербайджан) и мировыми лидерами (Швейцария, Швеция, США). Несмотря на улучшение позиции Узбекистана до 79-го места в рейтинге GII в 2025 году, результаты инновационной деятельности существенно отстают от вложенных ресурсов, формируя средний разрыв эффективности в –23 позиции. Тогда как Казахстан и Азербайджан демонстрируют показатели ниже ожидаемого уровня, Индия, Вьетнам и Марокко достигают более высоких результатов, чем прогнозируется по уровню их затрат. Основная проблема Узбекистана заключается не в недостатке инвестиций, а в слабой коммерциализации исследований, ограниченном экспорте высоких технологий и недостаточных связях между промышленностью и наукой. Исследование подчёркивает необходимость усиления координации национальной инновационной системы, привлечения иностранных инвестиций и развития венчурного финансирования по секторам для формирования инновационной экономики.

Ключевые слова: инновационная эффективность, Глобальный инновационный индекс (GII), Узбекистан, сравнительный анализ, инновационная политика, коммерциализация R&D, национальная инновационная система.

INTRODUCTION

Innovation serves as a fundamental engine of economic growth, enabling countries to achieve sustainable development beyond their basic resource-based capacities. Classical growth accounting within the Solow model demonstrates that technological innovation contributed approximately 85% to U.S. economic growth during the 20th century, surpassing the combined impact of labor and capital inputs. This emphasizes that innovation is the primary driver of productivity growth, competitiveness, and long-term improvement in living standards, particularly for developing and transition economies. In Uzbekistan, economic modernization necessitates a shift from resource-driven expansion—based on labor, capital accumulation, and natural resources—toward an innovation-driven model. The Government of Uzbekistan has initiated reforms aimed at strengthening the national innovation system and increasing research and development (R&D) capacity to support this transition (UNESCO, 2024).

However, increasing investment in innovation inputs alone does not guarantee growth; what matters is the effectiveness with which these inputs are transformed into tangible innovation outputs, such as patents, scientific publications, high-tech production, and creative goods. Global experience shows that innovation efficiency—rather than investment volume—determines whether spending on human capital, research, and institutional development results in measurable technological and economic gains (Tziogkidis et al., 2018). For emerging economies, this transition presents a strategic risk: without effective conversion mechanisms, countries may struggle to escape the middle-income trap. Therefore, evaluating how efficiently Uzbekistan converts innovation inputs into outputs is an urgent and policy-relevant research task.

This study analyzes Uzbekistan's innovation performance using Global Innovation Index (GII) metrics and compares it with global innovation leaders and emerging innovative economies. By benchmarking performance against both advanced and overperforming middle-income economies, the study identifies whether Uzbekistan must expand input investments or strengthen its conversion mechanisms, including commercialization linkages, intellectual property markets, and institutional frameworks. The research offers data-driven insights for innovation policy design, contributing to national innovation system development in Uzbekistan and informing strategies for similar transition economies.

Research Objectives

This study evaluates Uzbekistan's innovation efficiency using comparative GII output/input metrics. The specific objectives are as follows:

1. To calculate Uzbekistan's innovation efficiency ratio (innovation outputs relative to inputs) for the period 2020–2025 and examine its trend.
2. To compare Uzbekistan's innovation efficiency with advanced high-income innovation frontrunners (e.g., Switzerland, Sweden, United States) and with middle-income overperformers (e.g., Vietnam, India, Morocco).
3. To identify GII pillars/sub-pillars that most significantly influence Uzbekistan's efficiency performance, determining whether the country requires stronger inputs or improved conversion mechanisms.

The results will support policy decision-making by indicating whether Uzbekistan should prioritize increasing innovation investments or reinforce conversion systems—such as industrial–research linkages, commercialization incentives, and institutional coordination—to generate stronger outcomes. This research provides an evidence-based benchmarking model that contributes both to academic understanding of national innovation systems and to practical policy guidance for Uzbekistan and similar transition economies.

LITERATURE REVIEW

Endogenous growth theory (Romer, 1990) and the literature on national innovation systems (Freeman, 1987) both affirm a fundamental relationship between innovation and long-term economic development. According to OECD (2023), innovation enhances total factor productivity and sustains growth even when returns on capital accumulation begin to diminish. Therefore, developing and transitional economies must expand their innovation capacity to avoid growth stagnation and accelerate convergence with advanced economies. Empirical studies similarly demonstrate that innovation outputs—such as patents, high-technology exports, and R&D commercialization—positively influence GDP growth in developing countries (Bakari, 2024). Likewise, research on East Asian economic transformation confirms that as nations transition from resource-driven to knowledge-driven growth, innovation gradually becomes the primary engine for productivity improvements and industrial competitiveness (Kim & Nelson, 2000).

Studies focusing on Uzbekistan and Central Asia emphasize the strategic need for innovation-based growth to replace dependence on low-cost production and natural resources. A recent UNESCO (2024) policy profile underscores the importance of building a comprehensive national innovation system to support sustainable development. The literature highlights that fragmented institutions and weak linkages between industry and research organizations hinder the translation of scientific and educational achievements into marketable technologies. As a result, investments in human capital and research may not yield expected outcomes unless institutional coordination and commercialization pathways are strengthened.

Innovation efficiency is defined as the effectiveness with which a country converts innovation inputs into measurable outputs. The Global Innovation Index (GII) incorporates this concept through the Innovation Efficiency Ratio (IER), which reflects the ratio between a country's Output Sub-Index and Input Sub-Index scores (Tziogkidis et al., 2018). Tziogkidis et al. (2020) show that rankings based on efficiency can differ substantially from overall GI rankings because efficiency assesses how well resources are utilized, whereas overall scores may reward the sheer volume of innovation inputs. For this reason, large economies such as the United States or China may appear less efficient than smaller economies that produce strong outputs relative to modest input levels. To measure cross-country innovation efficiency more accurately, recent studies apply quantitative tools such as Data Envelopment Analysis (DEA), highlighting the role of institutional quality, policy coordination, and industry–academia linkages (Guan & Chen, 2012; Nasierowski & Arcelus, 2003).

A substantial body of literature examines the notable success of middle-income “innovation achievers,” countries that generate disproportionately strong innovation outputs relative to their input indicators. WIPO and PatentRenewal.com (2024) report that India, Viet Nam, and the Philippines consistently outperform expectations in GI output rankings. This performance is attributed to strong STEM skills, export-oriented industrial development, and policies aimed at aligning research outputs with commercial markets. These countries demonstrate that targeted industrial policies, human capital development, and regulatory reforms can yield high innovation efficiency even with limited resource allocation.

Conversely, studies also indicate that countries facing low innovation efficiency typically confront structural challenges such as limited venture capital markets, weak commercialization mechanisms, and insufficient alignment between educational outputs and private sector demand (Lema et al., 2021). For example, although Gulf countries invest large financial resources in R&D, their innovation outcomes remain constrained by market structure, governance issues, and weak private-sector engagement. These cases further underscore the importance of not only investing in innovation inputs but also improving the quality of institutional frameworks that enable commercialization and productive utilization of knowledge.

RESEARCH METHODOLOGY

This study employs a quantitative comparative approach using secondary data from the Global Innovation Index (GII) spanning the years 2020–2025. The purpose is to evaluate Uzbekistan's innovation efficiency by comparing its input–output performance with established global technology leaders and emerging high-performing economies. The analysis focuses on how effectively innovation inputs are transformed into measurable outputs.

Descriptive and comparative analytical techniques are used to evaluate Uzbekistan's trends over time and relative to specific benchmark economies. All data are obtained exclusively from annual GI reports published by WIPO, INSEAD, and Cornell University, which provide standardized scores for input and output sub-indices across 139 economies. Supplementary context is based on innovation policy reports issued by UNESCO (2020) and OECD (2023). All indicators are normalized on a 0–100 scale, enabling direct cross-country comparisons without additional statistical modification.

Two reference groups are utilized for benchmarking:

- Innovation Leaders: Switzerland, Sweden, and the United States — economies consistently ranked in the global top five for both input and output indices, representing highly efficient innovation systems.
- Innovation Overperformers: India, Viet Nam, and Morocco — middle-income economies identified by WIPO as generating innovation outputs that exceed expectations based on their input levels and economic status.

Uzbekistan is selected as the focal case because it represents a transforming economy that has demonstrated growth in innovation investments and institutional reforms but requires assessment of the effectiveness of such inputs in generating outputs.

Innovation efficiency is measured using the Innovation Efficiency Ratio (IER):

$$\text{Innovation Efficiency} = \frac{\text{Innovation Outputs (index score)}}{\text{Innovation Inputs (index score)}}$$

A ratio above 1 (or an output rank outperforming the input rank) indicates efficiency or overperformance, whereas a ratio below 1 denotes underperformance. When only ranks are available, an input–output rank differential is applied:

$$\text{Efficiency Differential} = \text{Input Rank} - \text{Output Rank}$$

Positive values indicate relative efficiency, while negative values suggest opportunities to improve output generation.

The methodology integrates three analytical components:

- 1.Trend Analysis: Uzbekistan's input and output ranks from 2020–2025 are plotted to illustrate its efficiency trajectory.
- 2.Cross-Country Benchmarking: Uzbekistan's 2025 efficiency differential is compared with both high-performing and lower-performing nations to highlight potential improvement strategies.
- 3.Decomposition Analysis: Performance across the six GII pillars — Institutions, Human Capital and Research, Infrastructure, Market Sophistication, Business Sophistication, and Knowledge & Creative Outputs — is examined to identify structural strengths and areas requiring further enhancement.

ANALYSIS AND RESULTS

Uzbekistan's Innovation Efficiency: Trends and Status

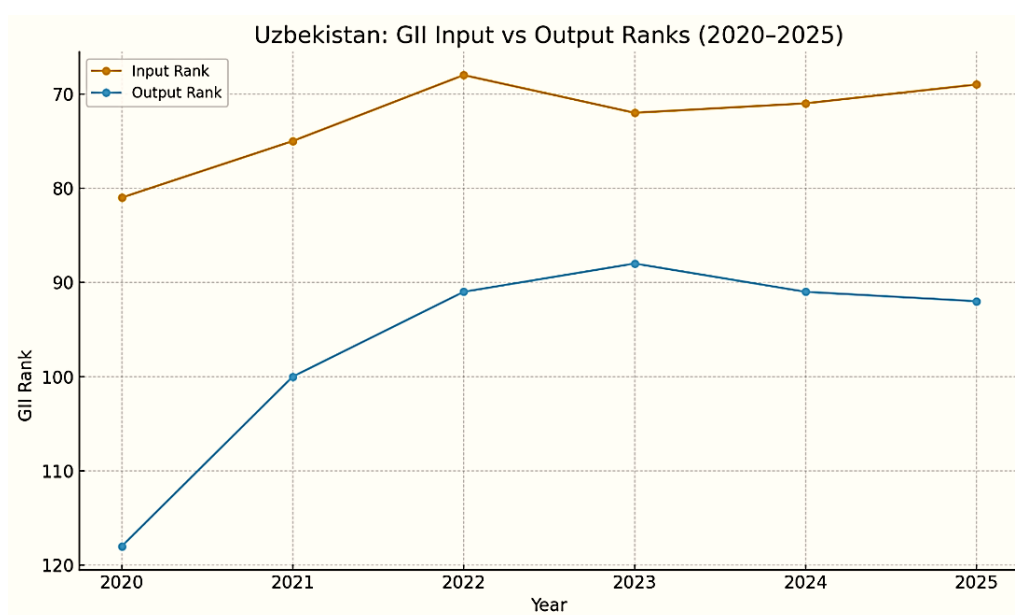


Figure 1. Uzbekistan's Global Innovation Index (GII) Input vs Output Ranks (2020–2025)

Source: Author's analysis based on WIPO GII (2020–2025).

GII data from 2020–2025 illustrate the trajectory of Uzbekistan's innovation input and output performance. The country demonstrated gradual progress in institutional quality, infrastructure development, and business sophistication because its input ranking improved from 81st in 2020 to 69th in 2025. Similarly, the innovation output ranking increased from 118th in 2020 to 88th in 2023, reflecting improvements in innovation results. However, outputs slightly declined to 91st–92nd positions during 2024–2025, indicating slower growth in commercialization and knowledge production relative to input expansion.

The input–output gap narrowed to –16 positions in 2023, marking the most efficient year within the observed period, yet it widened again to –20 to –23 in 2024–2025. This pattern suggests that Uzbekistan's innovation capacity—enabled through funding increases, institutional reforms, and infrastructure development—has grown faster than its ability to convert this capacity into measurable outcomes. The observed conversion gap is associated with limited research commercialization, underdeveloped high-tech export channels, and modest scientific publication intensity. Rather than indicating a deficiency in investment, the results emphasize the need to reinforce mechanisms that transform research and institutional support into economic outputs.

These findings confirm that Uzbekistan is building the foundational elements of its national innovation system but must now strengthen the conversion phase, particularly through industrial–research partnerships, intellectual property market development, and support for commercialization through venture capital and technology transfer programs. This shift would enable sustained innovation-based growth and improve global efficiency rankings over time (Figure 2).

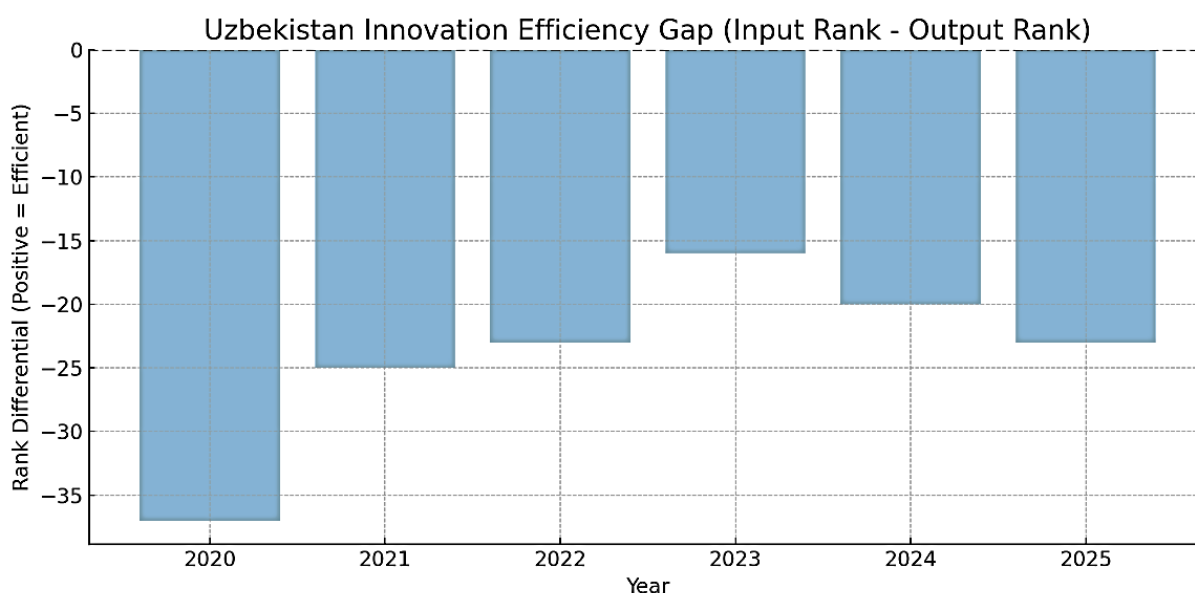


Figure 2. Innovation efficiency gap for Uzbekistan (Input rank minus Output rank)

Source: Author's analysis based on WIPO GII (2020–2025).

Figure 2 summarizes the rank differential between innovation inputs and outputs (Input – Output). The data presents negative values across all observed years, indicating a consistent gap between investments and resulting innovation outputs. The most favorable year is 2023 (–16), which suggests a temporary improvement in translating inputs into measurable results. However, the widening gap to –20 in 2024 and –23 in 2025 indicates that Uzbekistan's conversion mechanisms still require further strengthening.

These findings highlight policy priorities aimed not only at increasing innovation inputs but also at enhancing systems that convert these inputs into commercialized and knowledge-based outputs. Key strategic reforms include strengthening university–industry collaboration, improving technology transfer and commercialization systems, expanding intellectual property protection incentives, promoting exportable knowledge goods, and supporting publication and patenting activities. According to the Global Innovation Index (2024), Uzbekistan displays relatively strong innovation input performance compared to its output results, signaling the need to further develop efficiency mechanisms rather than solely expand investment volume.

The pattern observed does not imply failure in innovation development; rather, it reflects an early-stage innovation system where foundational investments are being made faster than commercialization structures can utilize them. This underscores the importance of coordinated policies that integrate R&D funding with market-oriented outcomes (Table A).

Table A. Uzbekistan's GII Input/Output Ranks and Innovation Efficiency Differential (2020–2025)

Year	Input Rank	Output Rank	Efficiency Gap (Input – Output)
2020	81	118	-37
2021	75	100	-25
2022	68	91	-23
2023	72	88	-16
2024	71	91	-20
2025	69	92	-23

Source: Author's calculations based on WIPO GII data (2020–2025).

Table A provides the numerical foundation for Figures 1–2. The data indicate steady improvement in Uzbekistan's innovation input ranking, rising from 81st to 69th over the 2020–2025 period. By contrast, output rankings display a less stable trajectory, fluctuating between 118th and 88th, before settling at 92nd in 2025. The efficiency differential reached its lowest point at –16 in 2023, reflecting a temporary improvement in output generation, but widened again to –20 (2024) and –23 (2025), revealing that the transformation of inputs into measurable outputs remains in its formative stage.

Despite this internal conversion gap, Uzbekistan is classified as an “innovation overperformer” relative to its GDP per capita. GII reports in 2023–2024 position Uzbekistan above the expected innovation trendline for countries at similar income levels. In other words, the country's aggregate innovation score is higher than predicted for its development stage. This suggests that Uzbekistan successfully builds foundational components of innovation capacity—particularly institutions and human capital—more rapidly than comparable economies. However, the outputs derived from these investments grow more slowly, which reflects not inefficiency in spending, but a need for stronger commercialization and connection mechanisms to generate economic and technological outcomes.

The 2024 GII report confirms this trend: Uzbekistan demonstrates faster structural development than its income level would predict, yet produces fewer innovation outcomes than its accumulated inputs would imply. This pattern is characteristic of economies transitioning from factor-driven growth to innovation-based strategies. It underscores the importance of building effective conversion mechanisms, including technology transfer, intellectual property markets, venture finance, and industry–research collaboration.

Benchmarking Against Global Leaders

To examine structural gaps more precisely, Uzbekistan's innovation efficiency is compared with leading global performers. Switzerland, Sweden, and the United States symbolize high-income innovation models where substantial investments are accompanied by robust conversion systems.

For example, Switzerland ranked 2nd in input and 1st in output performance in 2024 (WIPO, 2024). Its Innovation Efficiency Ratio approaches or exceeds 1, reflecting world-class conversion of scientific and institutional inputs into advanced technological and creative outputs. This is attributable to a highly coordinated National Innovation System, where research excellence, strong industrial R&D, high commercialization rates, and global intellectual property markets interact symbiotically (PatentRenewal.com, 2024).

Similarly, Sweden ranked 3rd in input and 2nd in output, demonstrating consistently high efficiency. Sweden's top ranking in global infrastructure and business sophistication aligns with its strong knowledge and technology outputs. Its innovation leadership is reinforced by strong STEM talent, industry–research integration, and supportive business ecosystems.

The United States presents a slightly different pattern. Although it consistently ranks among global leaders, its 2024 GII results show an input position of 4th and an output ranking of 5th, producing a small negative efficiency differential. This is attributed partly to its comparatively lower infrastructure ranking (30th). Nonetheless, the United States remains one of the world's most innovative economies due to strong commercialization systems, advanced intellectual property markets, elite research institutions, and powerful private sector innovation.

The main insight from these leading economies is that top-tier innovation systems balance two components simultaneously:

1. high levels of investment, and
2. strong conversion mechanisms that transform inputs into marketable and scientific outputs through industry–research linkages, supportive intellectual property systems, and commercialization ecosystems.

To visualize this comparison, Figure 3 presents cross-country innovation efficiency for global leaders versus Uzbekistan and selected emerging performers (using 2025 GII data). Positive bar values indicate overperformance (outputs ranked above inputs).

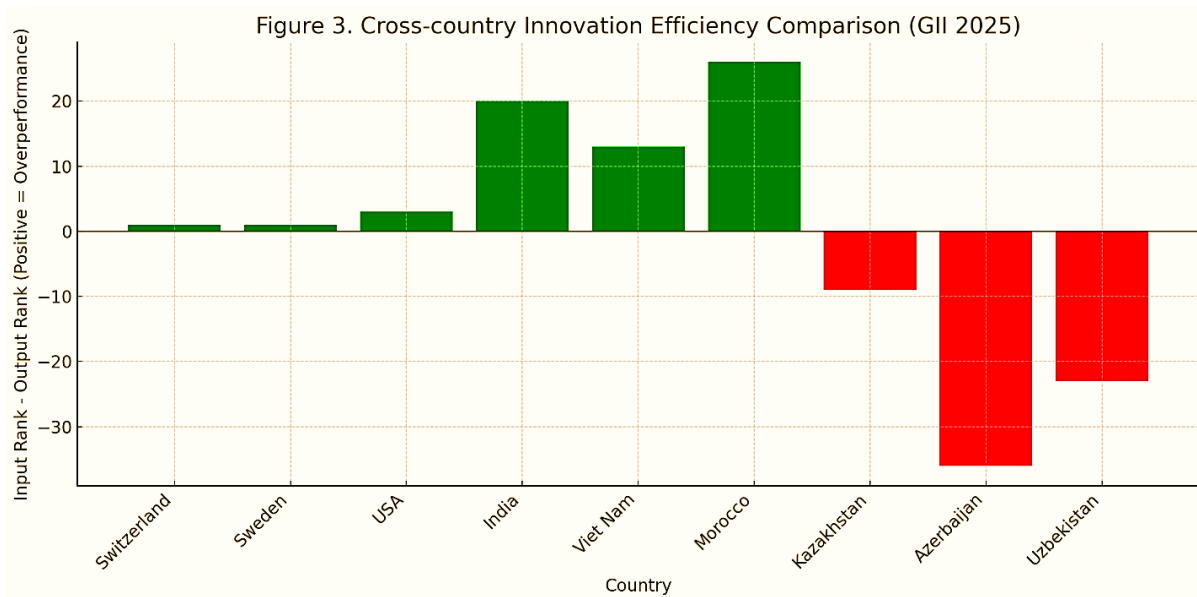


Figure 3. Cross-country innovation efficiency (GII 2025)

Source: Author's analysis based on WIPO GII (2025) data.

In 2025, Switzerland ranked second in innovation inputs and first in innovation outputs, resulting in a +1 efficiency differential, which reflects near-perfect efficiency. Sweden demonstrated a similar pattern, achieving a +1 differential, while the United States displayed a +3 differential, improving from sixth place in inputs to third place in outputs. These results illustrate that high-income leaders sustain strong conversion mechanisms, effectively translating research capacity and innovation investment into world-class outcomes.

Uzbekistan, by comparison, recorded a –23 differential, with its 69th input rank and 92nd output rank (WIPO, 2025). This gap does not indicate a lack of investment, but rather underscores the need to strengthen research–industry partnerships and improve commercialization processes. Kazakhstan (–9) and Azerbaijan (–36) also show varying degrees of under-efficiency, producing fewer innovation results than their input potential would predict.

A key structural difference lies in the composition and utilization of innovation inputs. High-income innovation leaders allocate substantial shares of their GDP toward research and development (often around 3% or more) and maintain high levels of researchers per capita, advanced STEM talent, and strong institutional frameworks. Uzbekistan demonstrates notable progress in foundational components such as secondary education participation and infrastructure, yet its R&D spending remains around 0.2% of GDP, limiting research conversion capacity.

High-efficiency systems—such as those in Switzerland and the United States—maintain robust academic–industry networks and mature venture financing structures. These enable research findings to transition smoothly into commercial products, patents, and startup enterprises. Correspondingly, Uzbekistan's performance in the Business Sophistication sub-pillar of the GII remains moderate, particularly in business-funded R&D and university–industry collaboration, though gradual improvement is evident. The differing outcomes can be illustrated through an individual example: a researcher in Switzerland is more likely to produce patentable technologies and high-impact publications than a researcher in Uzbekistan due to disparities in funding access, research networks, and the commercialization support environment.

Comparison with Innovation Followers/Overperformers

A more relevant benchmark for Uzbekistan is not high-income leaders but innovation overperformers among similar income groups. India, Viet Nam, and Morocco provide compelling comparisons. These economies belong to the lower-middle and upper-middle income categories but outperform expectations by prioritizing strategic specialization, export-driven industrial policy, and market-oriented innovation incentives. Despite resource constraints, they achieve strong innovation efficiency through targeted investments, STEM education reforms, and commercialization-focused governance. Their experience shows that innovation success can be achieved through strategic prioritization rather than high expenditure alone.

Table B. Cross-country Innovation Efficiency Benchmark (2025)

Country	Input Rank	Output Rank	Efficiency Score (Input – Output)
Switzerland	2	1	+1
Sweden	3	2	+1
USA	6	3	+3
India	52	32	+20
Vietnam	50	37	+13
Morocco	77	51	+26
Kazakhstan	75	84	–9
Azerbaijan	76	112	–36
Uzbekistan	69	92	–23

Source: Author's analysis based on WIPO GII (2025) data.

Table B presents numerical indicators supporting the results illustrated in Figure 3. Innovation leaders demonstrate a balanced alignment between input and output performance, reflecting comprehensive system readiness. Meanwhile, India, Viet Nam, and Morocco achieve strong conversion efficiency, generating innovation outputs that surpass expected levels for their stage of development. By contrast, Kazakhstan, Azerbaijan, and Uzbekistan exhibit persistent efficiency gaps, with output rankings trailing 9 to 36 places behind their input levels. Although Uzbekistan continues to strengthen its institutional foundations and human capital, its progress in research and development outputs remains comparatively limited, highlighting the need for enhanced commercialization mechanisms and private sector incentives.

India stands out as the most efficient innovator among lower-middle-income economies. In 2024, it ranked 44th in inputs and 33rd in outputs, showing an 11-position differential that reflects strong output generation relative to investment. This performance is driven by a well-developed ICT sector, robust STEM talent, venture capital-supported startups, and a large domestic market that accelerates technology diffusion. This suggests that Uzbekistan could benefit from leveraging its natural strengths, particularly by expanding IT outsourcing capacities and strengthening private sector systems that transform workforce skills into market-ready products.

Viet Nam represents one of the world's most efficient overperforming economies, improving to 50th in inputs and 37th in outputs in 2025 (+13 differential). Its success stems from export-oriented manufacturing, deep integration into electronics global value chains, and substantial foreign direct investment (FDI), despite modest R&D expenditure. Stable institutions and strategic education policies further support this trajectory. For Uzbekistan, Viet Nam's experience underscores the importance of attracting foreign investors, accelerating integration into global value chains, and linking innovation activity with export markets.

Morocco achieved one of the highest efficiency scores in 2025, shifting from 77th in inputs to 51st in outputs (+26 differential). This improvement reflects sector-focused policy reforms that emphasize education, high-tech production, and creative industries. Strengthened governance frameworks and productive university–industry partnerships have enabled Morocco to convert resources into patents, trademarks, and exportable knowledge products. For Uzbekistan, Morocco's strategy demonstrates the value of targeting specific innovation niches—such as agritech, renewable energy, or textile technologies—to improve innovation outcomes without proportionally increasing investment.

CONCLUSION AND RECOMMENDATIONS

This study demonstrates that Uzbekistan's current level of innovation efficiency remains below the global average. The country's output/input ratio has consistently stayed below 1 in recent years. Uzbekistan's GII Innovation Input ranks, which generally fall within the 60–70 range, exceed its Output ranks—typically in the 80–90 range—by 15 to 25 positions. These results indicate that investments in innovation are not yet being converted into proportional scientific, technological, or commercial outcomes.

When benchmarked globally, Uzbekistan performs significantly below leading innovation economies such as Switzerland and Sweden, which maintain close alignment between innovation inputs and outputs. More importantly, Uzbekistan also trails several innovation overperformers at similar income levels, including India, Viet Nam, and Morocco. These countries generate higher innovation outputs despite operating with similar—or in some cases, lower—input levels. The core challenges faced by Uzbekistan relate to comparatively low scientific publication and patent output, weak commercialization of research, limited high-tech product development, and insufficient industry–science collaboration. These challenges persist despite improvements

in education, entrepreneurship, and institutional development, suggesting that innovation system coordination and conversion mechanisms require greater focus.

The comparative analysis provides meaningful insights for both policymakers and researchers. India and Viet Nam illustrate how moderate investment paired with targeted specialization—especially in ICT services and participation in global value chains—can generate globally competitive outcomes. Morocco's recent gains show how shifting economic focus toward innovation-oriented sectors supported by coherent policy governance can rapidly enhance innovation outputs. In contrast, Uzbekistan's underperformance results not from a lack of talent or investment but rather from inefficiencies in converting inputs into outputs. Notably, the Global Innovation Index indicates that Uzbekistan performs above expectations for its income level, implying that the country has a strong foundational base. Closing the input–output gap would allow Uzbekistan to capitalize on this foundation and accelerate its innovation-driven development trajectory.

These findings contribute to academic discourse by showing that innovation efficiency varies widely among economies with similar income levels, and that strategic policy decisions can substantially influence efficiency outcomes. For policymakers, the results highlight that the quality of innovation processes and conversion systems is just as important as the quantity of innovation inputs.

Policy Recommendation (1)

2.Strengthen national innovation system (NIS) coordination.

Uzbekistan should improve system-level coordination to reduce duplication, enhance accountability, and streamline resource utilization. Establishing a high-level Science, Technology, and Innovation (STI) Coordination Council, or empowering a single lead innovation agency that includes representation from academia and industry, would strengthen governance. This aligns with UNESCO's recommendation to develop an integrated NIS structure. A clearly articulated national innovation strategy with defined roles for stakeholders should ensure that innovation inputs—such as funding, education, and Strengthen research-to-market transition mechanisms. Uzbekistan should intensify efforts to enhance the commercialization of research. This may be achieved through the establishment of technology transfer offices (TTOs) at universities, the creation of business incubators and accelerators for startups, and the introduction of incentives for collaboration between public researchers and private companies—such as grants that require industrial partnerships. Success metrics for public research institutes should prioritize outputs, including patents, licenses, and spin-off firms, rather than inputs such as research budgets and project counts. International examples, such as Türkiye's TUBITAK and Malaysia's commercialization grants, offer relevant models for program design tailored to Uzbekistan's context.

3.Leverage strengths in entrepreneurship and support scientific and technological outputs.

Uzbekistan's strong entrepreneurial culture (ranked 4th globally) should be complemented with initiatives that strengthen high-quality scientific research and intellectual property generation. This includes reward systems for researchers producing publications, especially in indexed journals, as well as streamlined patenting processes and incentives for filing international patents. Increasing participation in international conferences, collaborative projects, and global research networks may also enhance publication intensity. By converting human capital into knowledge outputs, innovation results can become more competitive globally.

4.Concentrate innovation efforts on strategic sectors.

Uzbekistan should identify and prioritize two to three competitive sectors, such as agritech, renewable energy, advanced textile materials, or ICT services, and direct targeted R&D funding, innovation grants, and incubation programs toward these fields. Creating sector-focused success stories generates spillover effects that raise overall output. For example, a national agro-innovation program could transform Uzbekistan's agricultural capabilities into innovative technologies—such as smart irrigation solutions or drought-resistant seed varieties—producing patentable and exportable goods.

5.Enhance financial instruments to support private-sector innovation.

While some financial indicators are promising, high-quality execution remains crucial. The government could expand innovation vouchers for SMEs to purchase R&D services from universities, offer tax incentives to companies investing in R&D and workforce training, and support venture capital ecosystems through public–private co-funding schemes. Strengthening angel investment and seed financing will enable entrepreneurs to translate ideas into market-ready products and services.

6.Invest in soft infrastructure and innovation culture.

Sustainable innovation efficiency requires not only investment in technology but also in the human infrastructure supporting it. Uzbekistan should train technology transfer specialists, intellectual property (IP) lawyers, and innovation managers, while encouraging a culture of experimentation and risk-taking within both public institutions and industry. Countries such as India have rapidly scaled innovation through hackathons, startup festivals, and university-based incubators. Uzbekistan has initiated similar activities, and scaling them further will help convert its young, educated population into innovative entrepreneurs and technology producers.

Limitations of the Research

This study relies primarily on descriptive analysis of GII data. Future research could incorporate econometric techniques or efficiency frontier models to deepen the understanding of innovation performance. For example, Data Envelopment Analysis (DEA) may provide a more accurate efficiency benchmark across comparable economies, following methods proposed by Tziogkidis et al. (2020). Additionally, regression analysis could be used to determine which sub-pillars—such as education, business sophistication, or market development—exert the greatest influence on Uzbekistan's innovation outputs. Combining quantitative methods with qualitative case studies could provide a comprehensive evaluation. As nationwide data access continues to improve, a regional assessment of innovation efficiency—comparing cities or provinces—would help identify internal best practices that could be scaled across the country.

Uzbekistan continues to progress toward building an innovation-driven economy. The next crucial step is to reduce the gap between innovation inputs and outputs. Drawing lessons from both innovation leaders and emerging overperformers can support improvements in innovation efficiency. Strengthening commercialization systems, sector-focused policies, and innovative financial instruments will enable Uzbekistan to fully leverage its human capital and institutional reforms. Successful implementation of these measures will not only improve the country's position in the Global Innovation Index but also accelerate economic diversification, technological advancement, and sustainable growth in the coming years.

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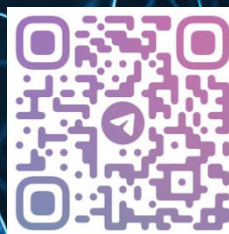
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