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THE ECONOMIC EFFICIENCY OF INTRODUCING SCIENCE AND INNOVATION INTO THE CONSTRUCTION SECTOR IN UZBEKISTAN AND STATE SUPPORT MECHANISMS

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Abstract

This article examines the economic efficiency of introducing science, research-based engineering solutions and innovation into the construction sector of Uzbekistan, with particular attention to state support mechanisms, institutional reforms, digitalization, energy efficiency, regulatory modernization and public-private interaction. The relevance of the topic is determined by the rapid growth of construction activity in Uzbekistan, the expansion of housing and infrastructure projects, the rising demand for safe and energy-efficient buildings, and the need to transform construction from a labor- and material-intensive sector into a technologically advanced branch of the national economy. In 2024, the volume of completed construction works in Uzbekistan reached 233.8 trillion soums and increased by 8.8% compared with the previous year; the number of enterprises and organizations engaged in construction activities reached 27,408 units as of January 1, 2025. These figures show that the sector is economically large, socially sensitive and institutionally complex; therefore, even a small improvement in productivity, design accuracy, material efficiency, energy consumption or project management can generate significant macroeconomic effects. The article argues that scientific and innovative development in construction should not be understood only as the use of modern equipment or digital software, but as a full-cycle transformation involving applied construction science, building materials research, seismic safety, BIM and digital twins, energy-efficient design, transparent permitting systems, public procurement, quality control, standardization, professional training and commercialization of research results. The methodological basis of the article is formed by system analysis, economic efficiency assessment, comparative institutional analysis and evaluation of state support mechanisms. The results show that the introduction of science and innovation into construction can reduce life-cycle costs, increase labor productivity, decrease project delays, improve safety, lower energy consumption, raise the quality of urban planning decisions and strengthen the competitiveness of domestic construction companies. At the same time, the article stresses a hard but necessary point: innovation in construction will not produce economic efficiency if it remains at the level of declarations, pilot projects or isolated digital platforms. Its real effect appears only when scientific results are translated into design standards, cost-estimate methods, building codes, procurement requirements, training programs, energy audits and measurable performance indicators.

Keywords: Construction sector, Uzbekistan, innovation, economic efficiency, science-based construction, state support, BIM, digitalization, energy efficiency, public procurement, building materials, urban planning, investment efficiency, construction policy.

Introduction

The construction sector occupies a special position in the economy of Uzbekistan because it simultaneously affects GDP growth, employment, fixed capital formation, housing supply, urban infrastructure, industrial demand, regional development and the quality of life of the population. Unlike many other sectors, construction has a strong multiplier effect: demand for cement, steel, glass, ceramics, polymer materials, transport services, engineering design, architectural services, installation works, machinery, energy systems and financial instruments is generated around each construction project. In 2024, Uzbekistan's GDP grew by 6.5%, investments in fixed capital increased by 27.6%, and construction was among the dynamically developing sectors of the economy. This creates a favorable macroeconomic background for the modernization of construction, but it also increases the cost of inefficiency: if projects are designed with errors, if materials are wasted, if buildings consume excessive energy, if permits are delayed, if seismic and safety requirements are weakly controlled, then the economy loses not only at the stage of construction but throughout the entire life cycle of buildings and infrastructure. Therefore, the main scientific problem of this article is not simply whether innovations are useful for construction; that is obvious. The harder question is under what institutional, financial and managerial conditions science and innovation actually create measurable economic efficiency in the construction sector of Uzbekistan. The Presidential Decree PF-6119 approved the Strategy for modernization, accelerated and innovative development of the construction industry for 2021–2025; the strategy defines priority directions such as urban development with public participation, improving quality and safety, ensuring transparency and rationality of administrative procedures, digitalizing urban planning activity, introducing modern information and communication technologies, improving personnel training and developing scientific potential in the field. This means that the state already recognizes construction innovation as a matter of public policy, not merely a private business decision. However, the existence of a strategy does not automatically guarantee economic efficiency. A weak assumption often made in policy discussions is that the introduction of digital platforms, new standards or innovation programs will automatically improve the sector. This assumption is incomplete. Digitalization can reduce corruption and transaction costs only if data are reliable, platforms are integrated, officials and companies actually use them, and project decisions are linked to accountability. Energy-efficient construction becomes economically rational only if energy audits, design calculations, tariffs, procurement rules and maintenance systems create incentives for saving. Scientific research becomes useful only if it is applied to real construction problems: seismic resilience, foundation design in difficult soils, thermal insulation, local building materials, durability of reinforced concrete, corrosion protection, structural monitoring, climate adaptation and urban infrastructure optimization. The purpose of this article is to analyze the economic efficiency of introducing science and innovation into Uzbekistan's construction sector and to justify state support mechanisms that can convert scientific potential into measurable economic results. The object of the research is the construction sector of Uzbekistan as a complex socio-economic and technological system. The subject of the research is the relationship between innovation, state support mechanisms and economic efficiency in construction. The scientific novelty of the article lies in treating innovation in construction not as a decorative modernization slogan, but as a life-cycle economic mechanism that affects costs, productivity, safety, energy consumption, investment attractiveness and long-term public value.

Methods

The research is based on a combined methodological approach that includes system analysis, institutional analysis, economic efficiency assessment, life-cycle cost logic, comparative policy interpretation and evaluation of state support instruments. System analysis is necessary because construction cannot be evaluated only through the direct cost of building works; it includes design, land-use planning, permitting, engineering surveys, procurement, material production, labor organization, quality control, commissioning, operation, maintenance, repair, energy consumption and eventual reconstruction or demolition. If innovation is introduced only into one link of this chain, the total economic effect may be weak. For example, BIM-based design may reduce design conflicts, but if procurement still rewards the lowest initial price rather than life-cycle performance, the economic benefit may disappear. Energy-efficient materials may reduce operating costs, but if the design documentation, construction supervision and maintenance system are poor, the actual savings may be much lower than the calculated savings. Therefore, the article evaluates innovation through a life-cycle efficiency model rather than a narrow one-time investment model. In formal terms, the economic efficiency of construction innovation can be expressed as

Eci=ΔCd+ΔCm+ΔCe+ΔCt+ΔQ+ΔS−ΔI−ΔRIs+iE_{ci}=\frac{\Delta C_{d}+\Delta C_{m}+\Delta C_{e}+\Delta C_{t}+\Delta Q+\Delta S-\Delta I-\Delta R}{I_{s+i}}Eci =Is+iΔCd+ΔCm+ΔCe+ΔCt+ΔQ+ΔS−ΔI−ΔR, where EciE_{ci}Eci is the coefficient of construction innovation efficiency, ΔCd\Delta C_{d}ΔCd is the reduction in design and documentation costs, ΔCm\Delta C_{m}ΔCm is the saving of materials and resources, ΔCe\Delta C_{e}ΔCe is energy cost saving during operation, ΔCt\Delta C_{t}ΔCt is the reduction of time-related costs and delays, ΔQ\Delta QΔQ is the economic value of improved quality and durability, ΔS\Delta SΔS is the value of increased safety and reduced accident or defect risks, ΔI\Delta IΔI is additional implementation investment, ΔR\Delta RΔR is innovation-related risk cost, and Is+iI_{s+i}Is+i is investment in science, research, digital systems and innovative technology. This formula is not proposed as a final accounting standard, but as a conceptual framework for assessing whether innovation is economically meaningful. The methodology also relies on normative analysis of the Urban Planning Code of Uzbekistan, which establishes the legal basis for regulating urban planning relations and defines the Ministry of Construction and Housing and Communal Services as the specially authorized state body in the field of urban planning. The same code provides that state regulation is carried out by the Cabinet of Ministers, the specially authorized body and local authorities, and that the Cabinet determines procedures for financing urban planning documentation, research in urban planning, norms and rules, licensing, examination and public procurement in this sphere. This legal framework is methodologically important because state support in construction is not limited to direct subsidies; it includes regulation, standards, procurement, public monitoring, licensing, examination, digital cadasters, professional certification and financing of research-based urban planning documentation. The article also uses a policy-analysis approach based on the national innovation strategy for 2022–2026, which emphasizes innovation infrastructure, state support mechanisms, innovative activity of small businesses, the creation of new technologies from idea to final consumer, and human capital development. The weakness of many innovation studies is that they describe the benefits of technologies without identifying who pays, who bears the risk, who verifies the result and who receives the economic gain. This article deliberately avoids that weakness by linking each proposed innovation to a corresponding state support mechanism and measurable efficiency indicator.

Results

The results of the study show that the economic efficiency of introducing science and innovation into the construction sector of Uzbekistan is formed through several interrelated channels, and the most important of them are cost reduction, productivity growth, quality improvement, energy saving, risk reduction, transparency of administrative procedures and creation of a domestic knowledge-based construction industry. The first efficiency channel is reduction of design and construction errors. In traditional construction practice, project documentation errors, inaccurate cost estimates, weak coordination between architects, structural engineers, utility designers and contractors cause rework, delays and additional costs. The introduction of BIM technologies, digital cost-estimate systems, three-dimensional coordination and digital twins can reduce these losses by detecting conflicts before construction begins. However, the effect depends on the maturity of the whole system: if only design organizations use digital models but expertise bodies, contractors and public customers continue to work with disconnected documents, BIM becomes a visual tool rather than an economic instrument. Therefore, the state support mechanism must be precise: public procurement for large projects should gradually require digital models, common data environments and machine-readable cost-estimate documentation, while universities and training centers should prepare specialists able to use these tools professionally. The second efficiency channel is material saving and technological modernization. Construction consumes large volumes of cement, concrete, steel, brick, insulation materials, aggregates, glass and finishing materials. Scientific research into local building materials, composite additives, low-clinker cement, recycled construction waste, thermal insulation, corrosion-resistant reinforcement and seismic-resistant structural solutions can reduce import dependence and improve durability. The risk here is clear: not every “local innovative material” is economically justified. If a material is cheaper at purchase but has lower durability, higher maintenance cost or weaker safety performance, it is not innovation; it is hidden inefficiency. Therefore, support mechanisms should include laboratory certification, pilot testing, technical approvals, life-cycle cost comparison and mandatory performance monitoring after implementation. The third efficiency channel is energy efficiency in buildings. This is one of the strongest areas where innovation can produce measurable economic returns, because buildings consume energy throughout decades of use. The World Bank’s Clean Energy for Buildings in Uzbekistan project shows the economic logic clearly: expected measures include energy audits, renovation packages, energy service agreements, monitoring and verification, and performance-based contracts; the economic analysis estimated positive economic net present value and economic rate of return, with higher benefits when avoided carbon emissions are included. The same source emphasizes that energy savings can be captured and reinvested through energy service agreements, while verification of savings requires sensors, energy bills, monitoring of indoor temperature, humidity and air quality, and continuous tracking of energy consumption. This matters for Uzbekistan because state support for energy-efficient construction should not be limited to slogans such as “green building” or “saving energy.” It must be based on energy audits, measurable baselines, verified savings, repayment mechanisms, and responsibility of contractors for actual performance. The fourth efficiency channel is administrative transparency and reduction of transaction costs. Construction is exposed to permits, cadastral data, urban planning restrictions, expert review, public procurement, technical supervision and commissioning. Every unnecessary administrative step creates costs, delays and corruption risks. The construction modernization strategy directly identifies digitalization, transparency and rational administrative procedures as priority directions. The economic effect of digitalization appears through shorter approval times, fewer informal payments, better access to urban planning information, improved monitoring and more predictable investment decisions. But the failure mode is also obvious: if digital platforms duplicate paper procedures instead of replacing them, the burden on business increases. Therefore, the key state support mechanism is not simply creating platforms, but integrating them, eliminating redundant procedures, publishing clear rules and connecting permits with cadastral, engineering, environmental and public monitoring databases. The fifth efficiency channel is safety and risk reduction. Uzbekistan is located in a seismically active region, and construction safety has direct economic value because structural failure causes not only human losses but also huge reconstruction costs, insurance losses, litigation, disruption of infrastructure and loss of public trust. Science-based construction must include seismic microzonation, geotechnical research, modern structural analysis, monitoring of critical buildings, quality control of materials and professional certification. The Urban Planning Code allows the use of international and foreign regulatory and technical documents adapted to the geological, climatic, seismological and other features of Uzbekistan, which creates a legal basis for gradual harmonization with advanced engineering practice. The sixth efficiency channel is development of human capital. Innovative construction cannot be implemented by software alone. It requires engineers who understand structural mechanics, materials science, geodesy, geotechnics, thermal physics, digital design, cost estimation, project management and standards. The national construction strategy identifies the improvement of training, retraining and qualification systems and the development of scientific potential as a priority. The economic value of this mechanism is long-term: better specialists reduce errors, improve design quality, select materials more rationally and increase productivity. But this channel is usually underestimated because it does not produce immediate visible results. In reality, weak human capital turns expensive technologies into unused equipment and turns digital platforms into formal reporting systems. The seventh efficiency channel is stimulation of innovative entrepreneurship and small business in construction. The national innovation strategy aims to expand innovation infrastructure, support start-up initiatives, increase the number of innovation-active organizations and strengthen the innovation activity of small businesses in regions. In construction, this can support start-ups and SMEs working in building diagnostics, energy audit, digital surveying, prefabricated construction, smart metering, material testing, waste recycling, modular housing, structural monitoring and construction management software. The realistic risk is that many start-ups may not survive long procurement cycles and conservative customer behavior. Therefore, state support must include pilot procurement, innovation vouchers, testing grounds, certification assistance and preferential access to public demonstration projects. The eighth efficiency channel is the creation of a domestic market for research-based construction services. If universities and research institutes produce studies that are not demanded by construction firms, scientific output remains isolated. If companies face real regulatory or procurement incentives to use research-based design, testing and monitoring, demand for applied science grows. Thus, the main result of the analysis is that economic efficiency emerges not from individual innovations but from a coordinated system: research → standard → pilot project →

certified technology → procurement requirement → mass implementation → monitoring → correction of standards.

Discussion

The discussion of state support mechanisms must begin with a strict distinction between productive support and decorative support. Productive support changes the behavior of construction companies, design institutions, customers and public authorities; decorative support only produces reports, conferences and isolated pilot projects. For Uzbekistan, productive support should include at least eight mechanisms. The first is regulatory modernization. Building codes, urban planning norms, material standards and cost-estimate rules must be regularly updated on the basis of scientific research, international experience and local climatic, geological and seismic conditions. The construction strategy sets the task of harmonizing national urban planning norms and rules with international standards while considering Uzbekistan's geological, natural-climatic and seismological characteristics. This is economically important because outdated norms increase costs in two opposite ways: sometimes they force excessive material consumption, and sometimes they permit unsafe or inefficient solutions that later create maintenance and reconstruction costs. The second mechanism is digital public administration in construction. "Transparent construction" systems, electronic permitting, digital urban planning documents, electronic registers of expertise and integrated cadastral data can reduce uncertainty and improve investment attractiveness. But the state should avoid a common trap: digitalization without process reengineering. If the old bureaucracy is transferred into an electronic form, the economy receives an expensive interface, not reform. Therefore, before digitalization, each procedure should be tested against three questions: is it legally necessary, does it reduce risk, and does it create measurable value? The third mechanism is public procurement reform. Since the state is a major customer in infrastructure, social facilities, schools, hospitals and public buildings, procurement rules can create demand for innovation. If tenders select only the lowest initial price, companies will avoid quality, energy efficiency and research-based solutions. If tenders evaluate life-cycle cost, verified energy savings, durability, seismic reliability, maintenance cost and digital documentation, innovation becomes economically rational. This is a decisive lever. The fourth mechanism is financial support through targeted grants, concessional loans, innovation vouchers, energy service agreements and revolving funds. The World Bank project on clean energy for buildings demonstrates how revolving energy cost savings and performance-based contracts can become a practical financial mechanism rather than a vague subsidy. For Uzbekistan, this approach can be adapted to schools, hospitals, administrative buildings, multi-apartment housing and municipal facilities. However, the risk is that energy savings may be overestimated. Therefore, subsidies and payments should be linked to verified performance, not promised performance. The fifth mechanism is support for construction science and applied research. This includes financing laboratories for building materials, seismic testing, geotechnical research, thermal performance testing, structural diagnostics and digital modeling. A serious weakness in many developing construction markets is that research institutions and industry operate separately. The construction sector needs contract research mechanisms: companies should be able to order practical research from universities and institutes, and the state can co-finance projects only when there is a real industry customer. The sixth mechanism is commercialization and certification of innovation. New materials, digital systems or engineering solutions cannot enter mass construction without testing, certification and technical approval. If this path is too slow, innovation dies; if it is too loose, safety suffers. Therefore, Uzbekistan needs a balanced system of accelerated technical assessment for innovative construction products, with strict performance criteria and post-implementation monitoring. The seventh mechanism is human capital and professional certification. Training should not be abstract. Engineers, designers, estimators, supervisors and contractors must be trained in BIM, seismic design, energy modeling, project management, life-cycle costing, quality control and digital permitting. The Urban Planning Code assigns the specially authorized body functions related to training, retraining and improving qualifications of specialists in architecture, design and construction, including cooperation with leading foreign research institutions. This creates a legal-administrative basis, but implementation must be tied to measurable competence. Certificates should not become formal documents; they should reflect real skills. The eighth mechanism is regional innovation policy. Tashkent and large cities are more likely to adopt new technologies, while regions may remain dependent on traditional methods. If innovation support is centralized, regional inequality in construction quality may increase. Therefore, regional testing centers, mobile laboratories, local material research, seismic microzonation maps and regional training hubs are necessary. The economic trade-off is clear: regional infrastructure requires budget spending, but it reduces future losses from poor-quality construction, inefficient energy use and urban planning mistakes. In addition, state support should not crowd out private initiative. The role of the state is to reduce uncertainty, set standards, create demand for verified innovation, co-finance high-risk research and protect public safety. The role of business is to invest, compete, improve productivity and deliver measurable outcomes. If the state carries all risk, companies become passive recipients of support. If the state provides no support, many socially valuable innovations will not pass the early adoption barrier. Therefore, the optimal model is shared-risk innovation policy: public money supports pilot testing, standards, training and verification, while private firms invest in scaling and commercialization.

Conclusion

The introduction of science and innovation into the construction sector of Uzbekistan has high economic potential, but this potential is conditional, not automatic. The sector is large enough for innovation to generate major economic effects: in 2024 alone, completed construction works amounted to 233.8 trillion soums, and the sector demonstrated significant growth. However, scale also means that mistakes are expensive. Poorly designed buildings, inefficient materials, weak supervision, excessive energy consumption, administrative delays and low professional competence impose hidden costs on the entire economy. The main conclusion of the article is that science and innovation increase economic efficiency in construction only when they are embedded into the full life cycle of a project: planning, design, permitting, procurement, construction, supervision, operation, maintenance and monitoring. The most important areas for Uzbekistan are BIM and digital design, energy-efficient buildings, seismic safety, local innovative materials, transparent permitting, life-cycle public procurement, construction waste recycling, performance-based contracting, applied research laboratories and professional retraining. State support mechanisms should therefore move away from general declarations and focus on measurable instruments: modernization of building codes, digital integration of administrative procedures, innovation-oriented public procurement, energy service agreements, revolving funds, pilot demonstration projects, certification support, university-industry research contracts, regional testing centers and strict monitoring of results. The weakest point in the current innovation chain is not the absence of ideas; it is the insufficient conversion of ideas into standards, certified technologies, procurement requirements and marketable products. If this gap is not closed, construction innovation will remain fragmented. If it is closed, the sector can become one of the strongest drivers of productivity growth, energy saving, safe urbanization, domestic industrial demand and technological modernization in Uzbekistan. The smallest realistic set of changes that can make the system work is the following: require life-cycle cost assessment in public construction projects, introduce mandatory digital documentation for large public projects, finance applied research only with industry participation, link subsidies to verified performance, create regional construction testing laboratories, and make professional certification competence-based. Without these changes, innovation will be expensive decoration. With them, it becomes an economic instrument.

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