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MODERN PROSPECTS FOR FINANCING THE MATERIAL AND TECHNICAL BASE OF HIGHER EDUCATION INSTITUTIONS

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ABSTRACT

This article examines modern prospects for financing the material and technical base of higher education institutions through a comparative analysis of official international datasets, national policy documents, and peer-reviewed literature. The study focuses on how systems fund laboratories, digital infrastructure, capital facilities, and research platforms. Evidence indicates that sustainable financing requires a blended structure combining core public funding, weighted allocation formulas, targeted capital grants, competitive project finance, moderate performance-based funding, and carefully governed revenue diversification. Cross-regional comparison demonstrates that public-dominant systems retain stronger baseline infrastructure security, while mixed public-private systems achieve higher spending but face volatility risks. Uzbekistan's PF-58 reform package is examined as a significant example of explicit infrastructure-linked financing. The article concludes that the material and technical base should be financed through a portfolio model based on adequacy, transparency, full-cost logic, and lifecycle asset management.

KEYWORDS

Higher education finance; capital funding; university infrastructure; performance-based funding; formula funding; public-private partnership; digital infrastructure; Central Asia; Uzbekistan; PF-58

Introduction

The material and technical base of higher education institutions, understood in this article as their physical, digital, laboratory, and research infrastructure, encompasses teaching and research laboratories, libraries, scientific equipment, information and communication technologies, digital platforms, energy systems, and all physical assets conditioning educational quality and research productivity. This base has become progressively more costly as higher education depends simultaneously on advanced research infrastructure, digital transformation, cybersecurity, and energy-intensive facilities. OECD evidence confirms that tertiary education is structurally more expensive than lower levels of the system and that the role of private financing is materially greater at the tertiary level (OECD, 2025).

The financing challenge has sharpened in recent years. UNESCO reports that households already cover one-quarter of all education expenditure globally, the annual financing gap to achieve education targets

remains near USD 100 billion, and aid to education is projected to fall sharply by 2027 (UNESCO, 2025). Within OECD systems, expenditure per student rose between 2015 and 2022, but education's share of total public budgets declined. This means tertiary systems may appear better funded in absolute terms while still losing relative budget priority. In such circumstances, deferred maintenance, inadequate laboratory renewal, and underinvestment in digital systems become common because capital needs are easier to postpone than salaries or current teaching operations.

The core research question of this article is: What financing architecture offers the strongest modern prospects for sustaining and upgrading the material and technical base of higher education institutions? The study addresses this question through a global overview and comparative regional examples from Europe, North America, East Asia, and Central Asia, with special attention to Uzbekistan's PF-58 reform package (President of the Republic of Uzbekistan, 2026). Existing research on higher education finance has largely focused on tuition policy, public expenditure, and performance-based funding, while the financing of physical, digital, laboratory, and research infrastructure remains less systematically examined, particularly in Central Asian higher education systems. This article contributes to the literature by linking higher education finance directly to infrastructure renewal and lifecycle asset management. It also examines Uzbekistan's PF-58 reform package as a recent example of infrastructure-sensitive and results-oriented financing in the region.

2. Literature Review

The literature relevant to this study can be divided into three strands. The first strand examines public funding, tuition dependence, and cost-sharing in higher education. The second strand focuses on performance-based and formula-based allocation mechanisms. The third strand addresses revenue diversification and infrastructure-specific instruments, including capital grants, PPPs, and competitive project finance. The scholarly literature on higher education finance has increasingly moved beyond tuition policy to examine the structural instruments through which systems pay for infrastructure. Matveeva (2025) provides a meta-narrative review of performance-based funding (PBF) in higher education, concluding that PBF effects are conditional and highly dependent on context, institutional capacity, and the proportion of total funding that is performance-contingent. Her analysis specifically notes that moderate, developmental performance funding linked to institutional mission differs substantially in its effects from punitive high-stakes PBF, and that systems with lower institutional capacity may require baseline adequacy grants before performance incentives are introduced. This finding has direct implications for capital infrastructure finance: systems that use performance funding to incentivize capital improvement must ensure that weaker institutions receive adequate baseline support to compete.

Dzhikiya, Karp, Bart, and Kukushkin (2023) examine public-private partnerships (PPPs) as a mechanism for education management within a social and investment model. Their study finds that PPPs can be effective for specific asset classes - student housing, utility infrastructure, and selected digital facilities - but that they are unsuitable as a general substitute for public capital funding due to contract complexity, affordability risks, and off-balance-sheet opacity. This aligns with OECD's broader finding that revenue diversification strategies, including PPPs, third-party funding, and new public sources, supplement rather than replace public funds (OECD, 2025). The World Bank's regional synthesis on Central Asia (2023) documents the particular challenges facing reforming systems: high

tuition dependence, current expenditure dominance, and limited visible fiscal room for capital investment within routine institutional budgets.

Taken together, the literature establishes two foundational conclusions relevant to the present study. First, no single financing instrument is sufficient for the material and technical base; effective systems combine instruments matched to different cost types. Second, capital expenditure requires visibility as capital - meaning it should be explicitly separated from routine operating finance - because systems that hide infrastructure costs inside general operating grants tend to accumulate maintenance backlogs and defer digital renewal. These conclusions are consistent across very different regional and institutional contexts and provide the analytical framework for the comparative analysis below. However, the literature has paid less attention to how these instruments can be combined specifically for financing the physical, digital, laboratory, and research infrastructure of higher education institutions in reforming Central Asian systems. In this context, Uzbekistan's PF-58 reform package is analytically important because it links public financing to institutional performance, discipline-specific cost differences, and the material-technical requirements of educational fields.

3. Methodology

This study employs a comparative descriptive design built on document analysis and cross-system benchmarking. The evidence base was restricted to official primary sources and selected peer-reviewed literature. Priority was given to OECD indicator reports and country notes, World Bank and UNESCO finance reports, national authorities' funding frameworks, and official legislation. Peer-reviewed articles were used to interpret contested instruments such as PBF and PPPs, not to replace official statistics (OECD, 2025). The country sample was chosen purposively to ensure regional coverage and data availability. Europe is represented by Germany, the United Kingdom, and Ireland; North America by the United States; East Asia by Japan and South Korea; and Central Asia by Kazakhstan, Tajikistan, Kyrgyzstan, and Uzbekistan.

The analysis examined five core variables: public/private funding structure; government expenditure per tertiary student; capital or infrastructure financing instruments; performance-based or results-oriented allocation mechanisms; and indicators of current expenditure pressure or tuition dependence. Funding design features directly relevant to the material and technical base were extracted, including discipline cost weights, capital grants, competitive equipment funds, infrastructure packages, development funds, and normative restrictions on research-fund use. A key methodological limitation is comparability: international capital-expenditure data are intrinsically volatile, and the Central Asia dataset combines different reference years by country. Results should therefore be interpreted as a structured cross-system benchmark rather than a harmonized panel.

Table 1. Source Base, Variables, and Analytical Use

Source Family	Representative Source	Variables Extracted	Analytical Use
International official statistics	OECD Education at a Glance 2025	Public/private shares, gov't expenditure per student	Cross-country benchmarking
Global finance monitoring	UNESCO GEM / Education Finance Watch	Finance gaps, aid trends, household contributions	Global contextualization
National policy documents	Ireland HEA; Uzbekistan PF-58	Funding formulas, performance funding, infrastructure packages	Institutional design analysis
Official US statistics	NCES Digest / IPEDS	Revenue-source time series, public-institution finance	Trend analysis
Regional synthesis	World Bank Central Asia Report (2023)	Public funding as % GDP, tuition dependence, per-student funding	Central Asia comparison
Peer-reviewed journals	Matveeva (2025); Dzhikiya et al. (2023)	Interpretation of PBF and PPP mechanisms	Discussion of instrument design

Note. Sources selected for official status, international comparability, and direct relevance to infrastructure financing.

4. Results and Discussion

The results demonstrate that no single financing instrument is sufficient for the material and technical base. Systems combine public operating support, targeted capital funding, project finance, and institution-level diversification. OECD reports that nearly one-third of tertiary funding now comes from private sources across OECD countries in 2022. Yet public and government-dependent higher education institutions still rely predominantly on public resources: public funds account on average for about 74% of spending, tuition fees provide about 15%, and all remaining private, philanthropic, and non-profit sources account for only 11%. This is a critical finding: diversification matters, but it does not remove the centrality of public finance.

Table 2. Comparative Financing-Model Archetypes for the Material-Technical Base

Archetype	Dominant Revenue	Typical Instruments	Examples	Strengths	Main Risks
Public-dominant block-grant	High public share; low household burden	Core grants, discipline weighting, capital envelopes	Germany, Finland	Stable baseline infrastructure	Declining budget priority; hidden deferred maintenance
Mixed public-fee-performance	Public grants + regulated fee income	Block grant, top-slices, performance funding	Ireland, UK	Strategic steering, expansion capacity	Student-market volatility; equity concerns
Diversified market-research	Tuition, state appropriations, federal grants	Capital appropriations, federal research, philanthropy	United States	High total spending, multiple funding channels	Revenue volatility; stratification risk
Household-intensive East Asian	Lower public share; strong private role	Public subsidies, household payments, project finance	Japan, South Korea	Rapid expansion under constrained budgets	Affordability pressure; unequal infrastructure quality
Reforming performance-autonomy	Public anchor + formula and incentive logic	Per-student costing, ranking incentives, cluster finance	Uzbekistan (PF-58)	Strong policy leverage; explicit infrastructure recognition	Implementation capacity; data-governance demands

Note. Comparative synthesis from OECD country notes, OECD sustainability analysis, Irish HEA framework, and Uzbekistan PF-58.

European evidence shows that capital and strategic funding are increasingly layered on top of formula allocations. Ireland's Higher Education Authority allocates more than EUR 1 billion annually through its Recurrent Grant Allocation Model, which combines a block grant, top-sliced ring-fenced funding, and performance funding weighted by discipline cost, research intensity, and access criteria. The INSPIRE program provides an additional EUR 750 million for research infrastructure - demonstrating that recurrent teaching finance and infrastructure renewal are treated as related but not identical problems (HEA, n.d.). OECD's 2025 sustainability report confirms this design logic: infrastructure finance works best when capital is visible as capital, not hidden inside general operating support (OECD, 2025).

Table 3. Selected-Country Indicators Relevant to Infrastructure Finance

Region	Country	Public Share (%)	Govt. Exp./Student (USD PPP)	Key Infrastructure Implication
OECD average	OECD	~67%	15,102 + 6,343 private	Mixed financing increasingly essential
Europe	Germany	83.8%	19,500	Strong public base for labs and facilities
Europe	United Kingdom	44.0%	7,896 public	Very high total spending via large fee contribution
North America	United States	38.7%	14,046	Diversified channels; high spending but volatile
East Asia	Japan	37.5%	8,184	Lower public support; household channels under pressure
East Asia	South Korea	59.8%	6,617	Below-OECD-average public support per student

Note. OECD 2025 country notes. UK total expenditure per tertiary student: USD 35,350; US total: USD 36,274.

North American evidence illustrates the logic of diversification most clearly. In U.S. public degree-granting institutions, tuition and fees grew from approximately USD 48.1 billion in 2007-08 to USD 83.4 billion in 2021-22, while state appropriations fluctuated. Federal nonoperating grants rose sharply from USD 10.0 billion to USD 41.9 billion over the same period, and capital appropriations moved within a narrower band of roughly USD 5.5-7.1 billion (NCES, 2024a). The result is the coexistence of multiple channels with different cycles and risk profiles, rather than simple replacement of public finance.

Table 4. U.S. Public Degree-Granting Postsecondary Institutions: Selected Revenue Flows (USD Billions)

Fiscal Year	Tuition & Fees	State Appropriations	Federal Grants	Nonoperating	Capital Appropriations
2007-08	48.1	68.4	10.0		7.6
2011-12	65.4	58.8	23.2		5.5
2018-19	82.8	74.0	21.0		6.1
2020-21	81.9	75.5	36.3		6.1
2021-22	83.4	83.5	41.9		7.1

Note. USD billions, current dollars. Source: NCES Digest of Education Statistics 2023, Table 333.10.

Central Asia presents the clearest evidence that infrastructure finance cannot be treated as a derivative of generic university finance. A World Bank regional synthesis reports large disparities in total higher education funding per student: approximately USD 3,360 in Kazakhstan, USD 845 in Uzbekistan, and USD 585 in Tajikistan (World Bank, 2023). Current expenditures dominate spending in all four systems and reach 100% of total public-institution expenditure in Uzbekistan, leaving limited visible fiscal room for capital rebuilding inside routine institutional budgets. Tuition dependence is high: tuition revenues account for 40-50% of university revenues in Kazakhstan and 68.4% in Uzbekistan (World Bank, 2023).

Table 5. Central Asia Funding Indicators Relevant to the Material-Technical Base

Country	Public HE Funding (% GDP)	Total HE Funding/Student (USD)	Tuition Revenue Share	Current Exp. as % of Total	Students Paying Tuition
Kazakhstan	0.20	3,360	40-50%	98.0%	66%
Tajikistan	0.61	585	n.a.	99.8%	74.6%
Kyrgyzstan	0.18	n.a.	n.a.	97.7%	89%
Uzbekistan	0.89	845	68.4%	100.0%	83%

Note. World Bank regional synthesis (2023); mixed reference years. Values are structured benchmarks, not synchronous observations.

Uzbekistan's Presidential Decree PF-58 (2026) is especially significant because it moves infrastructure finance toward explicit design. The decree establishes a U10 framework for national research universities, introduces results-oriented financing from 2027 with incentives linked to national ranking positions, and creates a per-student state-grant costing formula that explicitly incorporates field complexity, the material-technical base required by disciplines, research orientation, and maintenance costs. It also allocates an additional 20 billion soum to the Higher Education Development Fund in 2026 and requires 70 billion soum annually from 2027, while allowing cluster projects involving

universities, foreign institutions, and sector partners to be financed up to 150 billion soum from the Science Financing and Innovation Support Fund (PF-58, 2026).

5. Conclusion

The evidence leads to a clear conclusion: the modern prospect for financing the material and technical base of higher education institutions is a blended public-centered model with visible capital architecture. This conclusion follows directly from the observed mismatch between increasingly complex infrastructure needs and the declining relative priority of education in public budgets. Systems that rely only on annual operating allocations tend to accumulate maintenance backlogs and postpone digital renewal, while systems relying too heavily on fees or volatile private channels face enrollment-related infrastructure shocks and institutional inequality.

Several policy implications follow. First, the minimum physical and digital conditions of higher education should remain publicly anchored. Second, capital should be funded as capital - teaching grants, strategic top-slices, research grants, and capital packages solve different problems and should not be collapsed into one opaque block. Third, performance funding can be useful, but only if it remains moderate, transparent, and mission-sensitive. The current literature does not support indiscriminate expansion of PBF; it points to the importance of context, design, and institutional capacity. Fourth, private and third-party funding should be treated as complementary: PPPs may be suitable for dormitories or utilities, but they are not a substitute for systemwide funding adequacy (OECD, 2025; Dzhikiya et al., 2023).

The strongest actionable policy package emerging from this evidence is as follows. Governments should preserve a public baseline for infrastructure adequacy; embed infrastructure intensity in per-student formulas; create multi-year capital envelopes tied to asset-condition data; separate research-project funding from construction finance; use performance funding sparingly and developmentally; and require full-cost, lifecycle asset management so that depreciation, deferred maintenance, and digital replacement are no longer invisible in university budgeting. These recommendations are consistent with OECD's finance architecture, Ireland's recurrent-grant model, NCES evidence on diversified revenue streams, and the results-based design of Uzbekistan's PF-58. Future research should address the limited comparability of international capital-expenditure series and the need for panel-level data on infrastructure conditions in reforming higher education systems.

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