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Article

Analysis of the Practice of Financing Infrastructure Projects Through Public-Private Partnership Mechanisms: Evidence From Educational Organizations

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Abstract: This study examines the financing of educational infrastructure through public-private partnerships (PPPs), drawing on international experience to assess the implications for improving PPP financing practices in Uzbekistan. The research employs a purposive comparative analysis of PPP financing practices in the United Kingdom, Alberta (Canada), the Republic of Korea, and Uzbekistan. The analysis draws on government audit reports, project documentation, regulatory frameworks, and disclosures from international development institutions. A reproducible, illustrative 25-year financial model is developed to compare three procurement and financing alternatives: traditional public procurement, conventional PPP financing, and blended PPP financing. Sensitivity analyses assess the effects of operational efficiency, discount rates, and additional fiscal support costs on the present value of government payments. International evidence reveals substantial differences in the financial performance of PPP arrangements. While audit findings from the United Kingdom indicate higher cumulative cash costs for a selected group of PF2 school projects, evidence from Alberta suggests estimated risk-adjusted present-value savings associated with bundled procurement. However, these findings are based on different evaluation methodologies and are not directly comparable. Under the model assumptions, conventional PPP financing increases the present value of government payments by approximately 21% relative to traditional public procurement. Conversely, blended PPP financing reduces this value by approximately 5% before accounting for additional fiscal support costs. This financial advantage disappears when the incremental present value of such costs exceeds approximately US$0.65 million. The findings suggest that blended PPP financing may improve the fiscal affordability of educational infrastructure projects under specific financial and institutional conditions. Nevertheless, the estimated benefits represent scenario-based outcomes rather than empirically verified savings from implemented projects in Uzbekistan. Effective PPP procurement requires comparable service-quality standards, transparent accounting of public subsidies, comprehensive fiscal-risk assessments, and performance indicators that remain within the private partner's operational control.

Keywords: public-private partnerships; educational infrastructure; blended finance; fiscal affordability; government payments; procurement efficiency; Uzbekistan

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1. Introduction

Education infrastructure requires both initial investment and reliable long-term maintenance. PPP contracts can combine these responsibilities and defer public payments, but private finance does not remove the need to fund the services. Whether a PPP offers value for money depends on costs, performance, competition and the allocation of risks; faster delivery or lower fiscal costs cannot be presumed.

Uzbekistan provides a relevant policy setting. Its Law on Public-Private Partnership of 10 May 2019 establishes a framework for long-term cooperation [1]. A 2022 joint institutional statement reports that preschool enrolment among children aged 3–6 increased from 634,000 in 2015 to almost two million in 2022 [2]. This is sector-wide growth during a broader reform period, not an estimate of the causal contribution of PPP subsidies. Official school-project announcements also provide a basis for examining prospective infrastructure financing [3], [4].

The aim of this article is to analyse international and national practice in financing education infrastructure through PPPs and to derive recommendations for Uzbekistan. It asks three research questions:

1. Which PPP financing models have countries used for education infrastructure, and with what results?
2. How has Uzbekistan financed education PPPs so far, and what are the gaps?
3. How does the structure of financing affect the fiscal cost of a school PPP to the state?

The literature treats PPPs as a way to change when and how the state pays for infrastructure, not as a source of free money. Studies differ on whether the efficiency gains outweigh the higher cost of private finance.

Theory. Grimsey and Lewis [5] define a PPP as a long-term contract in which a private partner finances, builds and operates a public asset and bears significant risk. Hart [6] and Iossa and Martimort [7] show that bundling construction with maintenance gives the builder an incentive to invest in quality that lowers later costs. Engel, Fischer and Galetovic [8] argue that private finance does not create fiscal space: it moves payments into the future, so any gain must come from efficiency.

Evidence on education PPPs. Patrinos, Barrera-Osorio and Guáqueta [9] classify education PPPs into infrastructure, management, demand-side and support-service contracts. Randomised studies of service PPPs found gains in enrolment and learning in Pakistan [10] and Liberia [11], with results varying widely between providers. Evidence on infrastructure PPPs comes mostly from audits and value-for-money reports rather than experiments. Aslam, Rawal and Saeed [12] conclude that the evidence base is still limited and that results depend on accountability.

Fiscal risk. PFRAM was launched in 2016; its 2019 version, PFRAM 2.0, supports assessment of project and portfolio fiscal implications [13]. Committed service payments and contingent exposures should be assessed separately. PFRAM informs fiscal analysis; it does not itself establish a legal expenditure ceiling.

Blended finance. OECD [14] examines how development finance can mobilise commercial capital. Concessional loans, grants and guarantees have different repayment and risk characteristics. Their public or donor cost must be disclosed alongside the financing benefit. A capital grant reduces the sum requiring repayment; it is not automatically a first-loss instrument, which requires a contractual loss-absorption mechanism.

Research contribution. The article addresses the practical question of how financing assumptions change a school project's prospective fiscal cost. It combines a documented institutional comparison with transparent scenario calculations. It does not claim to establish that no previous study has modelled this question; demonstrating such an absence would require a systematic literature search.

2. Materials and Methods

The study combines a comparative case analysis with an illustrative financial model. The case analysis answers the first two research questions; the model answers the third.

2.1. Comparative case analysis

Four cases were purposively selected for contrasting institutional arrangements: UK PFI/PF2, Alberta's ASAP I, Korean Build–Transfer–Lease (BTL), and Uzbekistan's preschool and school initiatives. The evidence consists of identified audit and value-for-

money reports, official development-institution announcements and legal texts. It is a focused documentary comparison rather than a systematic review. Sources are assessed by contract model, financing and payment arrangements, scale, reported result and evidential limitation. Historical announcements are dated explicitly; they are not treated as evidence of completion or current tender status. The review was updated on 23 October 2026.

2.2. Illustrative financial model

The model compares one hypothetical school under three procurement and financing scenarios. All costs and rates in Table 1 are author assumptions, not observations from Uzbekistan. Construction occurs at time zero and operations last 25 years; payments occur at year-end. All cash flows are expressed in a common US-dollar denomination with no escalation, and rates are held constant. This stylisation is not a forecast of Uzbek dollar borrowing costs or a recommendation for foreign-currency borrowing.

Table 1. Author assumptions for the hypothetical school

Parameter	A Budget procurement	B Conventional PPP	C Blended PPP
Construction cost, US$m	10.000	9.200	9.200
Annual maintenance, US$m	0.200	0.184	0.184
Time-zero grant	Full capital cost	None	15% = US$1.380m
Equity share and return	Not applicable	20% at 15%	15% at 13%
Concessional debt	None	None	30% at 4%
Commercial debt	Not applicable	80% at 10%	40% at 8%
Repayable principal, US$m	Not applicable	9.200	7.820
Term and discount rate	25 years; 7%	25 years; 7%	25 years; 7%

The reference construction cost is US$10 million and annual maintenance is US$0.20 million. Separate efficiency parameters eC and eM reduce PPP construction and maintenance costs; both equal 8% in the base case solely for illustration. The 8% assumption is not inferred from Alberta's 13% value-for-money estimate, which includes different components and risk adjustments. The common discount rate is 7%, with 5% and 9% tested. It is a hypothetical fiscal valuation rate rather than a measured sovereign financing rate. Direct budget capital expenditure is counted at time zero; adding borrowing repayments as well would double-count it. Equivalent services and end-of-term asset condition, with no differential residual value, are assumed.

2.3. Equations and fiscal boundary

Let $a(k,n) = k / [1 - (1+k)^{(-n)}]$ be the annuity factor and $D(d,n) = [1 - (1+d)^{(-n)}] / d$ the present-value factor. Let C = 10, M = 0.20 and n = 25; monetary values are US$ millions.

For each PPP: CP = C(1 − eC), MP = M(1 − eM), G = gCP and F = CP − G. Here g is the grant share; G is a budget outflow at time zero, and F is the amount repaid through the capital component of availability payments.

The financing proxy is $k = \Sigma(wj \times rj) / (1 - g)$, where wj are shares of total construction cost and $\Sigma wj = 1 - g$. Conventional: k = 0.20×0.15 + 0.80×0.10 = 11.00%. Blended: k = (0.15×0.13 + 0.30×0.04 + 0.40×0.08)/0.85 = 7.4706%. Grant funding is excluded from the repayable-capital denominator.

Annual availability payment AP = F×a(k,n) + MP. Baseline budget cost PVA = C + M×D(d,n). PPP fiscal cost PVP = G + AP×D(d,n) + H, where H is the incremental present value of additional net public support and project costs not already included. Percentage difference = 100×(PVP/PVA − 1).

H includes any additional expected net guarantee or termination cost, administration and other incremental support. It excludes amounts already captured in scheduled payments. Its zero base-case value is a simplifying assumption, not evidence that

guarantees are free. Sensitivities add US$0.25m, US$0.50m and US$1.00m as hypothetical present-value burdens.

The WACC annuity is a pricing approximation, not a prediction of a financing waterfall. A robustness check prices each financing layer separately: AP_layer = Σ[wj×CP×a(rj,n)] + MP. Equity is represented as a level capital-recovery stream at its assumed return; actual distributions need not follow this pattern.

With eC = eM = e, base-case PPP cost before H is (1 − e)K. For conventional finance, K = [C×a(0.11,n)+M]D(d,n). For blended finance, K = gC + [(1−g)C×a(k,n)+M]D(d,n). Thus e* = 1 − PVA/K; with support cost H held fixed, e* = 1 − (PVA−H)/K.

The boundary is recipient-government payments, not economic cost–benefit analysis. The comparison omits equal teaching costs across options. It neither monetises learning gains nor claims financial bankability, debt-service coverage or economy-wide welfare benefits. A grant is counted once, and concessional debt is assumed to be borrowed by the project company and repaid through availability payments; sovereign on-lending would require tracing its separate cash flows [13].

3. Results

3.1. International practice

The cases illustrate different contractual approaches rather than a ranking of national performance. The UK observation concerns cumulative cash spending for a particular group of PF2 schools [15]. Alberta's ASAP I report estimates a C$97 million, or 13%, present-value advantage for 18 schools against a modelled public-sector comparator, including risk transfer; this is not an experimentally identified saving from bundling alone [16]. Korean BTL arrangements provide a further institutional example of repayment through long-term public lease and service payments [17]. Table 2 records these differences.

Table 2. International cases and limits of comparability

Case	Model	Scale	Financing and payment	Reported outcome
United Kingdom, PFI/PF2	Design-build-finance-maintain (DBFM)	Hundreds of schools since the 1990s	Private equity and commercial debt, repaid by availability payments over 25–30 years	About 40% higher cumulative cash spending for one group; not a discounted national average (NAO, 2018).
Canada, Alberta ASAP I	DBFM, 2-year build and 30-year maintenance	18 schools in one bundle, signed 2008	Private finance repaid by the province over the contract term	Estimated C$97m (13%) risk-adjusted NPV advantage against a modelled comparator; not isolated bundling effect

Case	Model	Scale	Financing and payment	Reported outcome
				(Alberta Infrastructure, 2010).
Republic of Korea, Build-Transfer-Lease	Ownership passes to the state on completion; the private partner operates the facility	A dedicated programme for education facilities	State pays lease and operating fees tied to performance	Institutional evidence on BTL delivery and repayment; no comparable savings estimate used (ADB & KDI, 2011).

3.2. Practice in Uzbekistan

Uzbekistan's preschool arrangements combine support to non-state providers with regulatory and monitoring requirements. These should be distinguished from a school DBFM contract in which financing, construction and maintenance are procured together. Different provider types and legal periods should not be aggregated as one financing model.

Historical preschool framework. Resolution No. 378 of 19 May 2018 supported preschool PPP arrangements, including a subsidy benchmark linked to public preschool costs. It was repealed by Resolution No. 426 in August 2022 and is used here only as historical evidence. Preferential-credit conditions and subsidy rates should be evaluated for the applicable programme and legal version rather than treated as uniform terms for all operators [8].

Digital administration. Resolution No. 426 of 2 August 2022 provides for automated subsidy calculations and biometric attendance recording. These arrangements illustrate verification of eligibility and service use; they do not establish that attendance alone measures educational quality or that a building contractor should bear enrolment risk [19].

Preschool project preparation. ADB's announcement of 18 December 2024 describes advisory support covering up to 500 preschools across five regions: four additional regions and Samarkand, where advisory work was already under way. The announcement concerns project preparation and prospective capacity, not completed assets or demonstrated fiscal savings [20].

School infrastructure. IFC's 7 October 2021 announcement described advisory support for up to 15 schools. A separate official RFQ announcement dated 3 December 2025 concerned up to 12 schools and approximately 10,000 places in Andijan and Samarkand. These dated scopes are not added together or assumed to represent independent completed projects. Neither announcement establishes actual financing prices, contract award or operating outcomes [3], [4].

The PPP Law provides a framework for public support and availability payments [1]. This article does not infer the absence of fiscal controls from that law alone: budget legislation, implementing measures and project agreements also matter. The policy issue examined here is how a project appraisal should consolidate direct payments, grants and contingent support in a common fiscal assessment.

3.3. Model results

Table 3 Model results in US$ millions except rates and percentage differences. Source: author calculations from Table 1 and Section 3.3; H = 0.

Table 3 reports the simplified annuity model. Conventional PPP finance has an 11.00% weighted rate. Blended finance has a 7.47% rate on the 85% repayable share, not on total construction cost. At an 8% assumed reduction in both construction and maintenance costs, the conventional option raises discounted state payments by 20.63%, while the blended option lowers them by approximately 5.27% before incremental support costs. The difference is conditional on the assumed concessional pricing and performance; it is not a measured benefit of actual procurement..

Indicator	A Budget	B Conventional	C Blended
Rate on repayable capital	Not applicable	11.00%	7.47%
Time-zero outlay, US$m	10.000	0.000	1.380
Annual payment, US$m	0.200	1.276	0.884
PV before additional costs, US$m	12.331	14.875	11.679
Difference against A	Reference	+20.63%	-5.29%

The tables below report efficiency, discount-rate and support-cost sensitivities. Efficiency is varied equally for construction and maintenance only for tractability. The conventional option breaks even at about 23.7% efficiency; blended finance breaks even at about 2.9% before additional support costs. These are scenario thresholds, not estimated attainable efficiencies. Subsidy and guarantee burdens can reverse the ranking.

Table 4. Efficiency sensitivity at a 7% discount rate and H equal to zero

Efficiency	B PV US$m	B vs A	C PV US$m	C vs A
0%	16.168	+31.1%	12.694	+2.9%
4%	15.521	+25.9%	12.186	-1.2%
8%	14.875	+20.6%	11.679	-5.3%
12%	14.228	+15.4%	11.171	-9.4%
24%	12.288	-0.3%	9.648	-21.8%

Table 5. Discount rate sensitivity at 8% efficiency and H equal to zero

Discount rate	A PV US$m	B vs A	C vs A
5%	12.819	+40.3%	+7.9%
7%	12.331	+20.6%	-5.3%
9%	11.965	+4.8%	-15.9%

Table 6. Incremental support cost sensitivity for blended finance

H PV US$m	C total PV US$m	C vs A
0.00	11.679	-5.29%
0.25	11.929	-3.26%
0.50	12.179	-1.23%
1.00	12.679	+2.82%

The separate-layer robustness check gives PV costs of US$14.911m for conventional finance (+20.92%) and US$11.795m for blended finance (-4.35%), before H. Differences from Table 3 reflect the nonlinearity of annuity factors. The base-case blended headroom for additional support is US$0.652m. Concessional access should also be tested for direct public procurement: if the same public-sector capital can be funded on comparable terms, the relevant comparator changes.

4. Discussion

The model shows how financing prices and public support affect discounted payments when service assumptions are held fixed. It cannot establish that financing design matters more than procurement quality, risk allocation or project selection, because those influences were not estimated independently.

Comparison with the literature. The model is consistent with the concern that expensive private capital can offset assumed operating efficiencies. The UK audit finding and Alberta's comparator-based estimate are contextual evidence, not validation of the model's numerical parameters. Contract bundling may reduce transaction costs, but may also reduce competition and increase delivery concentration; its effect requires project-specific assessment. The theoretical rationale for lifecycle incentives [6], [7] does not guarantee their realisation in every contract.

Implications for Uzbekistan. Four appraisal and contracting measures follow as proposals to test, rather than proven prescriptions for lower-cost delivery:

a. Assess layered finance alongside direct public procurement and public borrowing on comparable concessional terms. Specify the grant as a time-zero capital contribution. Identify beneficiaries, repayment obligations, guarantee coverage and any separately designed first-loss instrument. Test whether public support mobilises additional investment rather than merely subsidising capital that would have been available anyway.
b. Evaluate regional bundles through market sounding and competition analysis. Assess standardisation, transaction costs, local needs and contractor capacity before setting bundle size; a foreign comparator does not establish an optimal bundle for Uzbekistan.
c. Prepare a multiyear schedule of committed availability payments and separate contingent guarantees, termination compensation and currency exposure. Use PFRAM to inform appraisal, disclosure and stress tests, and apply the legally applicable budget and guarantee controls. Avoid treating the model's 7% discount rate as a statutory fiscal rule.
d. Link infrastructure payments to independently verified building availability, safety, condition, maintenance response and energy performance where controllable by the provider. Keep enrolment and learning outcomes at the education authority or operator level unless responsibility and risk are explicitly allocated. Publish deduction rules, verification procedures and dispute arrangements.

Limitations. The calculations are illustrative and use an aggregate WACC annuity rather than a full project-finance waterfall. Debt-service coverage, repayment grace periods, taxes, refinancing, construction delays, replacement cycles and detailed equity distributions are not modelled. Inflation and currency mismatch are omitted from the numeric base case, so the results should not be transferred to a local-currency contract with foreign debt. Guarantee sensitivities are assumed incremental net fiscal costs, not calibrated expected losses. A full assessment would estimate joint default scenarios, exposure, recovery, support fees and overlap with availability or termination payments to avoid double-counting [13]. Donor concessionality has an economic opportunity cost beyond the recipient-budget perspective. The case evidence has differing dates and evaluation methods, and neither the illustrative model nor enrolment trends identify causal PPP effects.

5. Conclusion

The evidence supports conditional conclusions. Education infrastructure PPPs create long-term funding obligations and may improve lifecycle incentives, but their value depends on financing, service delivery, competition and fiscal risk. The UK and Alberta findings use different measures and cannot be pooled into a universal PPP saving or premium.

For the hypothetical school, conventional PPP finance costs approximately 21% more in discounted state payments, while the blended scenario costs approximately 5% less before additional support costs. The apparent blended advantage is about US$0.65 million in present value and is eliminated when incremental fiscal support costs exceed that amount. It may also change with the discount rate or if equivalent concessional borrowing is available to direct public procurement.

Uzbekistan should therefore test financing structures against a risk-adjusted public-sector comparator before procurement. Pilot appraisal should disclose grants and guarantees, assess currency and termination risks, and use contractor-controllable performance indicators. Research should next apply the framework to disclosed contract cash flows and observed delivery outcomes; the present scenarios establish a transparent comparison method rather than a verified fiscal saving.

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