IMPROVING MECHANISMS FOR ASSESSING AND MINIMISING RISKS IN INVESTMENT PROJECT MANAGEMENT

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Abstract. The article examines why conventional, single-point appraisal of investment projects systematically understates risk and proposes an integrated mechanism for assessing and minimising risks across the project life cycle. The mechanism combines a structured risk register, sensitivity and switching-value analysis, Monte Carlo simulation of net present value, tail-risk indicators such as the probability of loss and expected shortfall, and a cost-effectiveness rule for selecting mitigation measures, supported by stage-gate monitoring with key risk indicators. The approach is demonstrated on an illustrative manufacturing project of 120 billion soums. The deterministic appraisal yields a positive NPV of 19.8 billion soums and an IRR of 21.4%, whereas the stochastic assessment, once realistic cost overruns and delays are included, shows a mean NPV of only 1.6 billion soums and a 50.7% probability of loss. A package of contractual and financial mitigation measures raises the mean NPV to 6.0 billion soums, cuts the probability of loss to 44.7% and improves the 5% expected shortfall by about 30 billion soums at a present-value cost of 7.5 billion soums. The results show that risk-adjusted indicators should become a mandatory part of project appraisal and monitoring in Uzbekistan’s rapidly growing investment programme.

Keywords: investment project, risk assessment, risk minimisation, Monte Carlo simulation, sensitivity analysis, expected shortfall, risk register, stage-gate control, project finance, Uzbekistan.

Investment activity is one of the main drivers of structural transformation in emerging economies, and the scale of capital expenditure makes the quality of project risk management a macroeconomic issue rather than a purely corporate one.

In Uzbekistan, fixed capital investment from all sources reached a preliminary 591.1 trillion soums in 2025, compared with 507.5 trillion soums in 2024. In January–September 2025 alone, investment amounted to 443.6 trillion soums, of which about 90% came from non-centralised sources such as enterprise funds, bank loans and foreign direct investment. When the bulk of investment is financed by enterprises and lenders, errors in project appraisal translate directly into non-performing loans, unfinished facilities and lost fiscal revenue.

International evidence shows that such errors are common. B.Flyvbjerg’s studies of large projects across many countries found that cost overruns and benefit shortfalls are the rule rather than the exception, and attributed them to optimism bias and strategic misrepresentation in the appraisal stage. The persistent gap between forecast and outcome indicates that the problem lies not only in the uncertainty of the environment but also in the appraisal methods themselves, which typically reduce an uncertain future to a single forecast of cash flows.

The aim of this article is to show how single-point appraisal distorts the risk profile of an investment project and to propose an improved, integrated mechanism for assessing and minimising risk that links quantitative assessment directly to the choice of mitigation measures and to monitoring during implementation.

The theoretical foundations of the topic go back to F.Knight’s distinction between measurable risk and unmeasurable uncertainty and to H.Markowitz’s portfolio theory, which established the variance of returns as a quantitative measure of risk. In capital budgeting, D.Hertz proposed replacing single-point estimates with probability distributions of key variables and simulating the resulting distribution of returns, an approach now known as Monte Carlo risk analysis. S.Savvides adapted this method to project appraisal in developing countries and showed how it reveals risks hidden by deterministic calculations.

A second line of research concerns flexibility. A.Dixit and R.Pindyck demonstrated that, under irreversibility and uncertainty, the option to wait, expand or abandon has value that the standard NPV rule ignores. The UNIDO manual by

W.Behrens and P.Hawranek remains a standard reference for feasibility studies and recommends sensitivity and break-even analysis as minimum requirements. At the level of management systems, ISO 31000:2018 defines risk management as an iterative process of identification, analysis, evaluation, treatment, monitoring and review, and the PMBOK Guide integrates these steps into the project life cycle. In risk measurement, P.Artzner and co-authors showed that expected shortfall, unlike value at risk, is a coherent risk measure and better reflects the severity of losses in the tail of the distribution.

Uzbek scholarship has addressed investment project management mainly from the standpoint of the stages of the project process, investment attractiveness and the management of the regional investment climate. Sh.Nishonova described the stages of investment project management and mechanisms for assessing investment attractiveness, and J.To’rayev examined the improvement of investment climate management using the example of Kashkadarya region. Studies that link probabilistic assessment of risk with a formal rule for choosing mitigation measures and with monitoring during implementation remain scarce. This gap determines the focus of the present article.

The mechanism consists of five interconnected stages, summarised in Table 1. Its key difference from conventional practice is that risk assessment does not end with a list of risks or a sensitivity table. Instead, quantitative results feed directly into a decision rule for selecting mitigation measures and into the indicators used to monitor the project after the investment decision.

Table 1

Stages of the integrated risk assessment and minimisation mechanism

Stage	Content	Tools	Output
1. Identification	Systematic listing of technical, market, financial, construction,	Risk register, expert workshops, checklists	Register with owners and early-warning signs

	regulatory and environmental risks		
2. Deterministic screening	Testing NPV against changes in each variable	Sensitivity analysis, switching values, scenarios	Ranking of critical variables
3. Probabilistic assessment	Joint simulation of critical variables	Monte Carlo simulation	NPV distribution, P(NPV<0), expected shortfall
4. Treatment	Selecting measures by cost-effectiveness	Contracts, hedging, insurance, staging, reserves	Optimised mitigation package
5. Monitoring	Tracking risk exposure during implementation	Key risk indicators, stage-gate reviews	Timely corrective decisions

The single-point appraisal of the illustrative project gives an NPV of 19.8 billion soums and an IRR of 21.4%, which exceeds the 17% discount rate. On this basis the project would normally be accepted. Sensitivity analysis, however, reveals how narrow the safety margin is (Table 2).

Table 2

Sensitivity of NPV and switching values (billion soums)

Variable	NPV at −10%	NPV at +10%	Switching value
Capital cost	31.8	7.8	+16.5%
Sales revenue (price or volume)	−12.9	52.4	−6.1%
Operating cost	38.4	1.1	+10.6%
Discount rate	28.9	11.5	—

Revenue is the most critical variable, since a decline of only 6.1% is enough to make NPV zero, while capital cost can rise by 16.5% before the project becomes unprofitable. Sensitivity analysis is useful for ranking variables, but it has two well-known weaknesses. It changes one variable at a time, although in reality several adverse deviations often occur together, and it says nothing about how likely each deviation is.

The Monte Carlo simulation removes both weaknesses. The results are shown in the first column of Table 3. Once realistic overruns, delays and joint variation of market and currency variables are taken into account, the mean NPV falls from 19.8 to only 1.6 billion soums, and the probability that the project destroys value rises to 50.7%. In the worst 5% of scenarios the average loss reaches 101.6 billion soums, which is close to the entire capital cost. In our view, this gap between the deterministic and the stochastic picture is the central finding. The deterministic NPV is not the expected outcome, because it silently assumes that the project will be completed on budget and on time, an assumption that the evidence on large projects does not support.

Table 3

Risk profile of the illustrative project before and after mitigation (10,000 simulations, billion soums)

Indicator	Without mitigation	With mitigation package	Change
Mean NPV	1.6	6.0	+4.4
Standard deviation of NPV	53.4	38.9	−27%
Probability of NPV < 0	50.7%	44.7%	−6.0 pp
5th percentile of NPV	−82.9	−56.6	+26.2
Expected shortfall (5%)	−101.6	−71.6	+30.0
95th percentile of NPV	92.8	71.5	−21.3

The mitigation package tested in the model includes four measures, each targeted at a variable identified as critical in the previous stages. First, a fixed-price engineering, procurement and construction contract with liquidated damages reduces the expected capital cost overrun from 12% to 4% and its standard deviation from 15% to 6%. Second, long-term offtake agreements with price-adjustment clauses halve the volatility of sales prices from 12% to 6%. Third, currency hedging or local sourcing of inputs reduces the exchange-rate shock affecting operating costs

from 10% to 4%. Fourth, early procurement of long-lead equipment and a dedicated commissioning team cut the probability of delay from 30% to 15%. The package is assumed to cost 1.6 billion soums per year in premiums, margins and contractual costs.

As Table 3 shows, the package raises the mean NPV by 4.4 billion soums, reduces the standard deviation by 27% and improves the expected shortfall by 30.0 billion soums. The present value of its cost over 10 years at 17% is about 7.5 billion soums. The resulting ratio of tail-risk reduction to the cost of mitigation is therefore about 4 to 1. We propose to use this ratio, the improvement in expected shortfall per unit of present-value mitigation cost, as a formal selection criterion. A measure or package is justified when the ratio exceeds a threshold set by the investor’s risk appetite, and measures are added in descending order of the ratio until the target level of tail risk is reached.

It should be noted that mitigation also lowers the upper tail of the distribution. The 95th percentile falls from 92.8 to 71.5 billion soums, since fixed-price contracts and offtake agreements transfer part of the upside to counterparties. This trade-off is inherent in risk transfer and must be made explicit to decision-makers. Even after mitigation the probability of loss remains 44.7%, which means that the project is still marginal. In practice, this result would be a signal to redesign the project, for example by phasing the capacity, rather than to accept it on the strength of a favourable single-point NPV.

Risk does not end with the investment decision. We propose that each risk in the register be linked to a key risk indicator with a threshold value that triggers a stage-gate review. For the illustrative project, such indicators include the cumulative cost performance index of the construction contract, the share of output covered by signed offtake contracts, the open foreign-currency position and the variance of the commissioning schedule. Reaching a threshold would require the project committee to re-run the simulation with updated data and decide whether to continue, adjust or stop the project. This creates a closed loop between assessment and management

and makes use of the real-option value of flexibility emphasised by Dixit and Pindyck.

For Uzbekistan, where the state, commercial banks and international financial institutions co-finance a large share of investment projects, the mechanism has a further practical implication. Requiring the probability of loss and the expected shortfall to be disclosed in feasibility studies, alongside NPV and IRR, would allow lenders and public bodies to compare projects on a risk-adjusted basis and to price credit and guarantees accordingly.

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