

Due Diligence of Infrastructure Projects – Roads and Bridges: A Review

¹Ram Prakash Singh, ²Mr. Rajesh Joshi

¹Research Scholar, Department of Civil Engineering, RGPM Bhopal

²Assistant Professor, Department of Civil Engineering, RGPM Bhopal

Abstract

Roads and bridges constitute the largest category of public infrastructure investment in India, increasingly relying on private capital through BOT, HAM, and DBFOT structures. Despite a mature policy framework anchored in the Model Concession Agreement, the sector continues to witness cost and time overruns, contract renegotiations, and premature concession terminations. A recurring diagnosis is the inadequacy of pre-award and pre-financial-closure due diligence. This thesis develops and empirically applies a structured Due Diligence Assessment Instrument (DDAI) integrating six dimensions—technical/engineering, financial/commercial, legal/contractual, environmental/social, regulatory/statutory, and risk/contingency—identified through literature review and refined through a two-round Delphi exercise with twelve domain experts. AHP weighting assigned highest importance to technical/engineering (0.24) and financial/commercial (0.22) due diligence.

The instrument was applied to two illustrative case packages: a road-widening BOT/HAM package (Case A) and a major bridge construction package (Case B). The application surfaced sixty-four red-flag findings, dominated by land acquisition and right-of-way (28%), design and geotechnical uncertainties (19%), and contractual/legal ambiguities (16%). A simulated cost-trajectory comparison indicates that structured due diligence embedded before financial closure can materially compress the cost-escalation envelope.

The study concludes that due diligence should be institutionalised as a staged, weighted, and auditable process rather than a single pre-bid compliance exercise, proposing a governance checklist, red-flag escalation protocol, and integration pathways into NHAI/State Highway Authority workflows.

Keywords: Due diligence; infrastructure project appraisal; Public-Private Partnership; roads and bridges; risk assessment; Analytic Hierarchy Process; Model Concession Agreement; project risk management; Delphi method; pre-financial-closure appraisal.

1. Introduction

This review paper examines an MTech thesis titled *"Due-Diligence of Infrastructure Projects – Roads and Bridges"* (by Ram Pratap), which addresses a persistent problem in Indian infrastructure delivery: despite a mature policy framework anchored in the Model Concession Agreement (MCA), road and bridge projects continue to suffer cost overruns, time delays, contract renegotiations, and premature concession terminations. The thesis argues that a recurring diagnosis across performance audits and academic research is the inadequacy of pre-award and pre-financial-closure due diligence—the systematic, multi-disciplinary verification of technical, financial, legal, environmental, and regulatory assumptions underlying a project.

The central research problem is: *How can a structured, multi-dimensional, and weighted due diligence framework be designed and applied to improve the identification, prioritisation, and mitigation of risks in Indian road and bridge infrastructure projects prior to financial closure?*

2. Objectives of the Study

The thesis is structured around six objectives:

1. To review and synthesise the technical, financial, legal, environmental, and regulatory dimensions of due diligence practice relevant to road and bridge projects.
2. To design a structured Due Diligence Assessment Instrument (DDAI) with defined dimensions, sub-criteria, and scoring guidance.
3. To establish relative weights of due diligence dimensions using the Analytic Hierarchy Process (AHP).
4. To apply the DDAI to representative road and bridge case packages.
5. To evaluate, through an illustrative simulation, the potential impact of structured due diligence on cost-escalation outcomes.
6. To propose recommendations for institutionalising structured due diligence within existing NHAI/State Highway Authority workflows.

3. Methodology

The study adopts a pragmatic, mixed-methods design combining qualitative expert elicitation with quantitative multi-criteria weighting and structured case application. The research proceeds through five stages:

1. **Literature Review** – Synthesis of due diligence dimensions from international PPP guidance, Indian statutory frameworks, and academic literature.
2. **Instrument Development** – Translation of synthesised dimensions into a structured instrument (initially 6 dimensions, 42 sub-criteria).

3. **Expert Validation (Delphi Review)** – Two-round Delphi exercise with 12 domain experts; consensus achieved on 34 retained sub-criteria ($\geq 80\%$ panel agreement).
4. **AHP Weighting** – Structured pairwise comparison by the same expert panel to derive dimension and sub-criterion weights; consistency ratio (CR) = 0.04 (acceptable).
5. **Case Application** – Application of the weighted DDAI to two illustrative composite case packages (Case A: road widening under HAM; Case B: major bridge under DBFOT), using document review, checklist scoring, and risk probability-impact mapping.

4. The Due Diligence Assessment Instrument (DDAI)

The DDAI comprises six dimensions and thirty-four validated sub-criteria, each assigned a global weight through AHP:

Dimension	Weight	Key Sub-Criteria (Illustrative)
Technical/Engineering	0.24	Geotechnical investigation coverage (0.050); DPR survey adequacy (0.045)
Financial/Commercial	0.22	Traffic & revenue forecast robustness (0.048); Capital structure & debt-equity adequacy (0.044)
Legal/Contractual	0.18	Land acquisition & ROW status (0.040); Concession agreement risk-allocation clarity (0.034)
Environmental & Social	0.14	Environmental clearance status (0.038); Resettlement & rehabilitation plan adequacy (0.032)
Regulatory/Statutory	0.12	Compliance with NHAI/State technical circulars (0.030); Toll notification compliance (0.024)
Risk/Contingency	0.10	Comprehensiveness of risk register (0.026); Contingency provisioning (0.022)

The instrument uses a 0–100 scoring anchor (0–39 = inadequate; 40–59 = partially adequate; 60–79 = adequate, minor gaps; 80–100 = fully adequate). Any sub-criterion scoring below 60/100 is automatically logged as a red-flag finding, ensuring a strong composite score cannot mask isolated severe deficiencies.

A standardised **Risk Register Template** records finding ID, dimension, description, probability (1–5), impact (1–5), risk score ($P \times I$), severity band (Low/Medium/High/Critical), cross-dimensional linkage, recommended mitigation, and responsible party.

5. Key Findings

5.1 AHP-Derived Weights

Technical/engineering (0.24) and financial/commercial (0.22) due diligence received the highest weights, reflecting expert judgement that design adequacy and financial structuring are the most consequential upstream determinants of project outcomes. Risk/contingency received the lowest weight (0.10), reflecting its role as a cross-cutting integration layer rather than an independent dimension.

5.2 Case Application Results

Both case packages scored nearly identical composite DDAI scores (Case A: 69.48; Case B: 69.88), but exhibited markedly different dimensional profiles:

- **Case A** scored strongly on technical (78) and regulatory (80) but weakest on risk/contingency (55) and environmental/social (60).

- **Case B** scored more evenly but with weaknesses in technical (70), risk/contingency (62), and legal (68).

This illustrates that a single composite score, reported without dimensional decomposition, obscures materially different risk profiles requiring different mitigation strategies.

5.3 Red-Flag Findings

The case application generated 64 distinct red-flag findings. The distribution was:

- Land acquisition & ROW: 28%
- Design & geotechnical: 19%
- Legal/contractual: 16%
- Financial structuring: 15%
- Environmental clearance: 12%
- Utility shifting: 10%

Three findings were classified as **Critical** (risk score 20–25): a bridge-foundation geotechnical data gap (Case B), a land-acquisition encumbrance affecting a 4 km stretch (Case A), and a force-majeure clause ambiguity (Case B).

5.4 Cross-Dimensional Risk Interaction

The DDAI's cross-dimensional linkage mechanism surfaced interactions invisible to siloed due diligence. For example, the Case B bridge-foundation data gap was cross-linked to:

- **Financial dimension** – foundation design uncertainty threatens the construction-cost estimate.

6. Recommendations

Recommendation	Primary Responsible Stakeholder
R1: Adopt a weighted, multi-dimensional due diligence instrument as a standard annexure to DPR appraisal	NHAI / State Highway Authorities; MoRTH
R2: Front-load land acquisition and ROW verification to pre-bid stage	NHAI / State Highway Authorities; State Revenue Departments
R3: Mandate cross-dimensional risk-interaction logging in lenders' engineer due diligence reporting	Lenders' Independent Engineers; Project Finance Banks/NBFCs
R4: Require mandatory senior-management/investment-committee escalation for any Critical-severity finding (risk score ≥ 20) prior to financial closure	Concessionaire SPV Boards; Project Appraisal Committees
R5: Periodically re-run AHP weighting with an updated expert panel to track evolving sector risk perceptions	Industry associations / professional bodies (e.g., IRC)
R6: Extend cross-dimensional linkage logic into post-award contract administration and structural health monitoring	Concessionaire Asset Management Teams; NHAI Monitoring Cells

- **Legal dimension** – unforeseen-ground-condition claims would test the concession agreement's variation mechanism.
- **Risk/contingency dimension** – contingency provisioning was benchmarked against historical averages rather than this specific elevated risk.

5.5 Cost-Escalation Simulation

An illustrative simulation modelled two trajectories against an approved-budget baseline (cost index = 100):

- **Without structured due diligence:** Critical and High-severity findings remain unaddressed until construction, compounding over the implementation phase.
- **With structured due diligence:** Findings are identified, escalated, and partially mitigated prior to financial closure.

The trajectories diverge most sharply beyond month 18, consistent with Flyvbjerg's finding that cost escalation is strongly associated with implementation-phase length. The simulation is explicitly heuristic rather than econometrically estimated.

5.6 Implementation Schedule

A representative Gantt chart shows that a structured, integrated due diligence exercise can realistically be completed within an 11–12 week pre-financial-closure window, addressing the objection that integrated due diligence necessarily implies slower appraisal.

7. Limitations

1. **Small expert panel (n=12)** – Purposive, non-random sampling appropriate for instrument development but limiting generalisability of specific AHP weights.
2. **Composite case packages** – Cases constructed from secondary sources rather than confidential primary data; findings illustrative of diagnostic capability, not audited project-specific results.
3. **Heuristic cost simulation** – Not econometrically estimated; should not be interpreted as a quantified return-on-investment claim.
4. **Qualitative risk scoring** – Retains irreducible expert judgement despite dual-rater and consistency-check procedures.

8. Directions for Future Research

1. **Longitudinal validation** – Test DDAI against actual project outcomes (cost/time variance, dispute incidence) across a larger sample of named, completed projects.
2. **Cross-sector extension** – Apply instrument to metro rail, ports, airports to assess generalisability of the six-dimension structure.
3. **Digital integration** – Link DDAI risk register with project-information platforms and structural health monitoring data streams.
4. **Behavioural barriers** – Investigate organisational and psychological obstacles to adopting structured due diligence beyond instrument availability.

9. Conclusion

This thesis makes a significant contribution to infrastructure project appraisal practice and literature. The DDAI operationalises six due diligence dimensions into 34 weighted, evidence-anchored sub-criteria with a standardised risk register, demonstrating through case application that structured, integrated due diligence can surface cross-dimensional risk interactions invisible to siloed practice. The finding that land acquisition and ROW status remains the single largest category of red flags reinforces existing policy recommendations while extending them through a systematic assessment framework.

While limitations—most notably reliance on composite rather than named case data and a purposively sampled expert panel—counsel caution in generalising specific numerical findings, the DDAI itself, together with its risk register template and institutionalisation recommendations, represents a practical, adaptable contribution toward more structured, integrated, and auditable due diligence practice in Indian road and bridge infrastructure development. The study successfully bridges the gap between theoretical risk

management frameworks and applied project appraisal practice, offering a template for similar instruments in other infrastructure sub-sectors.

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