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# Risk Identification and Prioritization in Construction Projects: A Probability–Impact Assessment and Risk Mitigation Framework

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**Abstract :** *Construction projects face interconnected uncertainties associated with design, scheduling, costs, resources, quality, environmental conditions, stakeholder coordination and regulatory approvals. This paper develops a structured framework for identifying, classifying and prioritizing construction project risks using a probability–impact (P–I) assessment and linking the resulting priorities to proportionate mitigation actions. The analysis is grounded in the supplied M.Tech. thesis, particularly its risk taxonomy, sample quantitative scoring table, probability–impact matrix, risk exposure ranking and mitigation planning discussion. The thesis describes a smart residential township case involving 250 housing units, a planned 24-month duration and a stated budget of ₹120 crore; it also identifies risks including approval delays, budget overrun, scope change, resource unavailability, poor communication, monsoon disruption, price escalation and smart-system integration issues. However, the thesis does not provide a transparent underlying dataset, respondent-level records, scoring protocol or independently verifiable project documentation for all displayed values. Accordingly, this paper treats those scores and case details as thesis-reported illustrative case material, not as independently validated empirical results. The proposed framework uses a five-point likelihood and impact scale, a transparent risk exposure score, category-based classification, explicit ownership, response selection, residual-risk review and periodic reassessment. The paper also critically discusses the limitations of multiplying ordinal ratings, the danger of treating a heat map as a precise quantitative model, and the need to preserve low-probability/high-consequence risks from being masked by average scores. Its contribution is a practical, auditable workflow for construction teams, while recognizing that empirical validation requires verified project records and structured expert or survey data.*

**Keywords**: construction project risk; risk identification; risk prioritization; probability–impact matrix; risk exposure; risk register; mitigation framework; project governance

## I. INTRODUCTION

Construction projects are temporary, multi-party undertakings in which design decisions, procurement, labour availability, site conditions, regulation and client requirements interact over time. A risk that initially appears local may propagate across work packages: a delayed permit can postpone mobilisation; postponed mobilisation can disrupt procurement and sequencing; and schedule compression can increase overtime, rework or quality exposure. Construction risk management therefore requires more than a list of possible problems. It requires a repeatable method to identify risk events, estimate their significance, decide which risks require action first, assign responsibility and monitor whether responses remain appropriate.

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Early construction risk research found that practitioners often relied on judgement and experience, while formal analytical techniques were not consistently used [1]. Later reviews confirm the dominance of probability–impact models while noting continuing challenges in modelling uncertainty, combining risk effects and making assessment tools usable in practice [2]. Risk assessment and allocation research also shows that project participants may rank the same risk differently depending on their roles and exposure [3]. A sound framework should therefore be simple enough for routine use but explicit enough to expose assumptions and disagreements.

The supplied thesis, titled "Investigate the Impact of Risk Management Strategies on Project Success in Terms of Time, Cost, and Quality," offers a useful starting point for a narrower paper. It lists technical, schedule, cost, quality, operational, external, stakeholder and legal/compliance risks; gives a sample five-point scoring approach; and presents a case narrative involving a smart residential township. Its Chapter 4 identifies a risk classification, a probability–impact matrix, risk exposure scores and corresponding mitigation actions. The present paper uses these components to address a different question from the thesis's broad time–cost–quality theme: how can a construction team move from risk identification to defensible prioritization and action?

The paper does not claim to reproduce an independently conducted field survey. Although the thesis abstract refers to survey responses from 300 project managers and interviews, the supplied thesis material available for this analysis does not provide raw responses, sampling details sufficient for replication, instrument items, statistical outputs or an auditable data file. Moreover, some figures are described as illustrative. The paper consequently distinguishes thesis-reported material from literature-based recommendations and proposed analytical steps.

### 1.1 Aim and objectives

The aim is to develop a transparent probability–impact assessment and mitigation framework that can be applied to construction projects using the risk categories and examples presented in the thesis.

The objectives are: (i) to organize construction risks into practical domains; (ii) to specify a consistent likelihood and impact scoring process; (iii) to demonstrate prioritization using thesis-reported risk examples without presenting them as verified measurements; (iv) to link priority levels to response strategies, ownership and monitoring; and (v) to critically identify the limitations and data requirements for empirical validation.

### 1.2 Research questions

RQ1: Which risk domains should be considered during systematic identification in construction projects? RQ2: How can likelihood and impact be combined to support transparent prioritization? RQ3: How should priority rankings translate into mitigation actions, ownership and monitoring? RQ4: What limitations arise when illustrative or judgement-based scores are interpreted as objective evidence?

## II. LITERATURE REVIEW

### 2.1 Construction risk as a structured management problem

Project risk is commonly treated as an uncertain event or condition that can affect objectives. In construction, sources include design development, contractors and subcontractors, material and labour markets, weather, site conditions, client decisions, contract arrangements and statutory approvals. The number of interfaces matters: even when individual work packages appear manageable, dependencies between them can amplify the effect of a disruption. Akintoye and MacLeod [1] describe the importance of risk analysis and management in construction and the historical dependence on intuition. This remains a practical warning: experience is valuable, but undocumented intuition makes comparison, escalation and learning difficult.

ISO 31000:2018 frames risk management as an integrated process involving identification, analysis, evaluation, treatment, monitoring, review, recording and reporting. It emphasizes that risk management should be integrated into governance and decision-making rather than treated as a separate exercise [4]. In project settings, the implication is that

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risk assessment must connect to procurement decisions, programme updates, design approvals, cost control, quality assurance and communication.

### 2.2 Risk identification and classification

Identification aims to create a sufficiently broad but usable picture of uncertainty. Methods include review of project documents, lessons learned, site inspections, brainstorming, expert judgement, structured checklists, SWOT analysis, interviews and analysis of work packages. No single method is complete. Checklists can reduce omission of familiar risks but may underrepresent novel project-specific risks; brainstorming broadens coverage but can be dominated by senior voices; expert judgement draws on experience but may be affected by optimism, availability bias or inconsistent interpretations.

A risk breakdown structure (RBS) groups risk events into a hierarchy so that teams can trace each risk to a source and work package. Research on Indian commercial construction has used RBS to organize risk categories and support assessment across projects (A comparative study of project risk management with risk breakdown structure, 2024). The supplied thesis uses a related classification, separating technical, schedule, cost, quality, operational, external, stakeholder and legal/compliance risks. In its case discussion, it additionally groups identified risks into time-related, cost-related, quality-related, environmental and regulatory domains. These classifications are complementary: the first describes the source or nature of risk; the second describes a project objective or area through which the risk may manifest. Sohrabinejad and Rahimi [5] likewise demonstrate that interdependencies among criteria may require more structured multi-criteria methods than a simple matrix.

A practical register should therefore avoid forcing each event into only one category. For example, a delayed environmental clearance is a regulatory risk by source, but it can create schedule and cost consequences. A smart-system integration failure is technical in origin but may produce quality defects, rework, delayed commissioning and stakeholder dissatisfaction. Recording both source and consequence improves traceability.

### 2.3 Probability–impact assessment

The probability–impact matrix is widely used because it is easy to explain and can help teams focus attention on combinations of likelihood and consequence. A common scoring method assigns likelihood and impact ratings on a fixed scale and calculates a product, often expressed as risk exposure = likelihood × impact. The supplied thesis uses a five-point scale in its sample construction risk scoring and gives examples such as utility relocation delay, steel-price escalation, design coordination error and monsoon flooding. Its Chapter 4 also describes a risk matrix and a ranked list of risks.

The method should be treated as a prioritization aid rather than a precise measurement of loss. Ordinal ratings such as “1 = rare” and “5 = almost certain” indicate ordered categories; they do not prove that the distance between 1 and 2 equals the distance between 4 and 5. Multiplying ordinal values can create an appearance of mathematical precision without establishing a ratio-scale measurement. Taroun [2] notes that probability–impact models dominate construction risk literature but that more comprehensive modelling is needed to reflect multiple project objectives and aggregate individual assessments. Acebes et al. [6] similarly argue for quantitative approaches beyond conventional probability–impact matrices.

A matrix can also hide the difference between risks with the same product. A likelihood rating of 5 and impact rating of 2 gives the same score as likelihood 2 and impact 5, although the response may differ substantially. Low-probability catastrophic risks may deserve mandatory treatment even when their product is not the largest. Interdependencies, cumulative effects and uncertainty in ratings also matter. Recent construction research using simulation has shown that uncertainty in probability and impact judgements and correlations among risks can change rankings and reveal risks overlooked by conventional matrices [7].

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### 2.4 Risk response and ownership

Risk response should be selected after considering the event, its causes, the potential consequences, the party able to influence it and the cost or feasibility of treatment. Typical strategies include avoidance, mitigation, transfer or sharing, and acceptance with monitoring or contingency. Transfer does not eliminate risk from the project system: insurance or contractual allocation may move some financial consequences, while residual operational or reputational exposure remains. El-Sayegh [3] shows the importance of considering risk allocation alongside assessment. ISO 31000 [4] likewise treats treatment as one stage in an iterative cycle, not as the final step.

A response becomes actionable only when it identifies an owner, an action, a deadline, the resources needed, a trigger or early-warning indicator and the residual risk after treatment. A risk register without owners often becomes a static list. A mitigation plan without triggers can fail to respond when conditions change. Risk management should be embedded in project reviews and updated when scope, schedule, market conditions or site information changes.

## III. MATERIALS AND METHODOLOGY

### 3.1 Research design

This paper adopts a critical document-analysis and framework-development design. The primary source is the supplied M.Tech. thesis by Banti Mandrah, completed in April 2025. Relevant material includes the thesis's risk taxonomy in Chapter 2; the sample quantitative scoring table; the time, cost and quality risk assessment discussions in Chapter 3; and Chapter 4's case narrative, risk classification, probability–impact matrix, risk exposure ranking and mitigation tables. External literature and ISO guidance are used to contextualize the approach and identify methodological limitations.

This is not a new survey, experiment or independent case verification. No new respondents were recruited, and no raw dataset was supplied for reanalysis. As a result, the paper does not calculate new inferential statistics, test hypotheses statistically or claim causal effects. The framework is a structured synthesis of the thesis content and established risk management literature.

### 3.2 Case material reported in the thesis

The thesis describes a large-scale smart and eco-friendly residential township in Pune, Maharashtra, attributed to EcoHabitat Developers Pvt. Ltd. The narrative states that the project involved 250 housing units, a planned duration of 24 months, a budget of ₹120 crore and an intended IGBC Platinum certification. It describes risks related to monsoon conditions, labour shortages, material-price changes, transportation costs, IoT-based smart-system integration, skilled labour, environmental clearance and land-use or permit changes. It also describes responses such as rescheduling selected works around monsoon conditions, modular construction, fixed-rate contracts and bulk procurement.

These particulars are reported as thesis case material. The supplied document does not include independently verifiable project records, contract documents, respondent-level data or a source trail sufficient to confirm the named company, project outcomes or the actual implementation of every mitigation measure. They are therefore not presented here as independently verified facts about a real project. The analysis uses them as the thesis's case scenario and illustrates how the framework would handle such risks.

### 3.3 Risk scoring procedure

The proposed process begins by writing each risk as a cause–event–effect statement. Likelihood (L) is scored from 1 to 5 using a project-specific definition agreed before scoring. Impact (I) is scored from 1 to 5 against the most relevant consequence dimensions, including schedule, cost, quality, safety, environment and compliance. A simple exposure score is calculated as $R = L \times I$, producing a range from 1 to 25. The score supports initial sorting but does not replace professional judgement or mandatory escalation criteria.

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| Rating | Likelihood descriptor | Illustrative interpretation |
|---|---|---|
| 1 | Rare | Unusual in the project context; credible evidence suggests very low likelihood. |
| 2 | Unlikely | Could occur, but not expected under current controls. |
| 3 | Possible | Plausible during the project; comparable events have occurred. |
| 4 | Likely | Expected to occur in some circumstances or controls are weak. |
| 5 | Almost certain | Expected to occur repeatedly or current evidence indicates imminent occurrence. |

| Impact rating | Illustrative consequence guide |
|---|---|
| 1 – Insignificant | Negligible disruption; handled within routine work-package tolerance. |
| 2 – Minor | Limited rework or short delay; manageable within local contingency. |
| 3 – Moderate | Material disruption requiring management intervention or budget/schedule adjustment. |
| 4 – Major | Significant milestone, cost, quality, safety, environmental or compliance consequence. |
| 5 – Severe | Threatens critical objectives, statutory compliance, safety, major certification or project viability. |

These descriptors are proposed operational definitions for this paper, not a claim that the thesis used these exact anchors. Before applying the method, the project team should tailor the thresholds to project size, contract obligations, legal requirements and stakeholder risk appetite.

### 3.4 Priority bands and escalation rules

For demonstration, scores of 1–4 are classified as low, 5–9 as moderate, 10–16 as high and 17–25 as extreme. These bands are a proposed management convention, not a universal standard and not a statistically validated classification. The team should approve its own thresholds and test whether they produce sensible decisions. In addition, any risk involving credible fatality potential, major environmental harm, serious legal non-compliance or loss of a critical permit should be escalated regardless of its product score.

### 3.5 Reliability, validity and ethics

A defensible assessment requires a common scoring guide, a documented source for each rating, and review by people with different responsibilities. Ratings should be independently elicited where feasible, discussed when they diverge, and recorded with a rationale rather than averaged automatically. A pilot assessment can identify ambiguous terms. Version control should preserve the original rating and explain later changes. As the paper uses thesis content and published sources rather than personal data, no new human-participant data were collected. Any future survey or interview study would require informed consent, confidentiality procedures and the relevant institutional ethics approval.

## IV. ANALYSIS OF THESIS-BASED RISK MATERIAL

### 4.1 Risk domains and interconnections

The thesis's risk classification provides a practical initial register. Its Table 2.4 identifies technical, schedule, cost, quality, operational, external, stakeholder and legal/compliance risks. Chapter 4's case analysis groups ten example risks across time-related, cost-related, quality-related, environmental and regulatory domains, with two risks in each domain. This even distribution is a classification table, not evidence that the domains occur with equal frequency in construction generally. The paper therefore treats it as a case-organizing device rather than a prevalence estimate.

| Risk event from thesis material | Primary source/domain | Potential consequences | Key interface to monitor |
|---|---|---|---|
| Monsoon delays or flooding | Environmental/site | Work stoppage, resequencing, temporary works, delay costs | Weather forecast, drainage readiness, seasonal programme |
| Labour shortage / skilled- | Resource/operational | Reduced productivity, rework, | Labour availability, |

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| | | | |
|---|---|---|---|
| labour gap | | schedule slippage | productivity, subcontractor capacity |
| Material price fluctuation | Market/cost | Procurement cost increase, budget pressure | Supplier quotes, price indices, purchase timing |
| Fuel and transportation cost increase | Logistics/cost | Higher delivered-material cost and supply delays | Transport rates, route access, delivery reliability |
| IoT/smart-system integration issue | Technical/quality | Testing failure, redesign, commissioning delay | Interface tests, design coordination, vendor readiness |
| Environmental clearance delay | Regulatory | Restricted work, resequencing, compliance exposure | Permit register, authority milestones, submission completeness |
| Policy or land-use change | External/regulatory | Redesign, delay, additional approvals | Regulatory monitoring, change control |
| Permit delay | Legal/compliance | Critical-path delay and potential contractual consequences | Approval tracker, escalation dates, responsible liaison |
| Budget overrun | Aggregate cost exposure | Funding gap, scope pressure, reduced contingency | Forecast-at-completion, commitments, change orders |
| Scope creep / poor communication | Stakeholder/governance | Unapproved work, rework, disputes and delay | Change log, decision turnaround, communication records |

The main analytical implication is that risk categories should not be treated as isolated silos. A permit delay may be the initiating event, schedule overrun the immediate consequence, and cost escalation the downstream effect. Similarly, a shortage of skilled installers can affect both the productivity of construction work and the quality of smart-system commissioning. The register should record one initiating event and multiple consequence pathways to avoid double-counting the same risk while still making cross-functional impacts visible.

### 4.2 Thesis-reported risk exposure scores

The thesis reports a top-five list with the following scores: budget overrun (25), scope creep (20), delay in approvals (16), resource unavailability (15), and poor communication (12). These scores are useful for demonstrating how a project team might sort a register. However, the document excerpt does not show the underlying probability and impact values for every item in that list, the source of each rating, who assigned them, or whether the scores were obtained from project data or are illustrative. They must therefore be described as thesis-reported scores, not independently calculated findings.

| Thesis-reported rank | Risk | Reported exposure score | Priority interpretation for this paper | Suggested initial response |
|---|---|---|---|---|
| 1 | Budget overrun | 25 | Extreme under the proposed bands; verify rating basis and cost exposure | Cost-to-complete review, change control, contingency governance, owner assigned |
| 2 | Scope creep | 20 | Extreme; manage through formal baseline and change approval | Scope freeze at agreed gates, impact assessment for every change |
| 3 | Delay in approvals | 16 | High; escalation may be | Permit register, submission- |

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| | | | | |
|---|---|---|---|---|
| | | | needed depending on critical-path effect | quality checks, authority liaison, float and escalation trigger |
| 4 | Resource unavailability | 15 | High; supply and workforce capacity need monitoring | Resource-loaded schedule, alternate suppliers, labour plan and look-ahead reviews |
| 5 | Poor communication | 12 | High; cross-functional controls are required | Responsibility matrix, decision log, meeting cadence and issue escalation |

A score of 25 can only be interpreted as the maximum product if the study used a 1–5 scale for both likelihood and impact. The thesis elsewhere uses that type of scale, but the scoring assumptions should be explicitly confirmed before this ranking is treated as a coherent quantitative result. The rank order may change if different teams use different rating anchors or if the score represents expert judgement rather than observed frequency and loss.

### 4.3 Case example: from risk score to response

The thesis's sample quantitative scoring table gives utility relocation delay a likelihood of 4 and impact of 5, yielding 20 and an "extreme" priority; steel-price escalation is scored 3 × 4 = 12; design coordination error 3 × 3 = 9; and monsoon flooding 2 × 5 = 10. These examples show that a high-impact risk need not have the highest probability to warrant attention. They also illustrate why the register should preserve the two component ratings instead of storing only the product.

| Risk example | L | I | R = L × I | Response indicated in thesis material | Critical check |
|---|---|---|---|---|---|
| Utility relocation delay | 4 | 5 | 20 | Resequencing, permit task-force, schedule float | Confirm utility maps, agency dependencies and latest approval status |
| Steel-price escalation | 3 | 4 | 12 | Price-lock contracts, contingency fund, alternative sourcing | Review contract clauses, validity periods and supplier concentration |
| Design coordination error | 3 | 3 | 9 | BIM-based clash detection, peer reviews | Track unresolved clashes and approval of coordinated drawings |
| Monsoon flooding | 2 | 5 | 10 | Temporary drainage, rescheduling during monsoon | Do not let moderate probability obscure severe safety/environmental impacts |

This table does not establish that the response measures were implemented successfully; it shows the logical connection between an identified risk and a proposed treatment. A complete register would add an accountable owner, action due date, required budget, trigger, residual likelihood and impact, and the date for the next review.

### 4.4 Why simple rankings need safeguards

Three risks with equal exposure scores may demand different actions. Scope creep can often be managed through governance and change control; permit delay depends partly on external authorities; and a technical integration risk may require testing, specialist resources and design decisions. A common score helps prioritize attention, but response selection should consider controllability, timing, legal obligations, risk velocity and dependencies. The team should also distinguish inherent risk (before controls) from residual risk (after existing controls) and target risk (after proposed treatment). Without these distinctions, the same risk can appear repeatedly in different registers and the effect of controls cannot be assessed.

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Risk prioritization is also dynamic. A permit risk may be high early in the project but fall once approval is secured. Conversely, a supplier risk may rise when lead times increase or a subcontractor's capacity changes. The register should be reviewed at defined gates and when triggers occur, not simply at monthly reporting intervals. For high risks, review frequency should be proportionate to how quickly the situation can change. This concern is consistent with Qazi and Simsekler [7], whose construction application found that modelling uncertainty and correlations can reveal high-exposure risks missed by conventional matrix rankings.

## V. PROPOSED PROBABILITY–IMPACT AND MITIGATION FRAMEWORK

### 5.1 Framework overview

The proposed framework contains eight linked steps: define project context and criteria; identify risks; classify and describe each event; score likelihood and impact; prioritize and apply escalation rules; select responses and assign owners; monitor triggers and residual exposure; and capture lessons for future projects. The steps are iterative. New risks may emerge during execution, and existing risks may change when assumptions, scope or external conditions change.

| Step | Core activity | Required output | Accountability |
|---|---|---|---|
| 1. Context | Define objectives, scope, constraints, risk appetite and scoring anchors | Approved assessment criteria | Project manager and client/sponsor |
| 2. Identify | Review documents, work packages, site conditions, interfaces and lessons learned | Initial risk list with evidence/source | Package leads and specialists |
| 3. Classify | Use risk breakdown structure and record causes, events and consequences | Categorized risk register | Risk coordinator and owners |
| 4. Assess | Rate likelihood and impact; record rationale and confidence | L, I, exposure score and assumptions | Multidisciplinary assessment team |
| 5. Prioritize | Apply score bands plus mandatory escalation rules | Ranked list and priority actions | Project manager / risk committee |
| 6. Treat | Choose avoidance, mitigation, transfer/share or acceptance; allocate resources | Response plan, owner, due date, budget | Named risk owner |
| 7. Monitor | Track triggers, actions, residual risk and changing conditions | Updated register and escalation log | Risk owner and project controls |
| 8. Learn | Review outcomes, near misses and response effectiveness | Lessons learned and revised checklist | Project leadership and organization |

### 5.2 Risk identification protocol

Before scoring, each risk should be written in a cause–event–effect form. For example: "Because environmental clearance documentation may be incomplete, the approval may be delayed, which could postpone site activities and increase time-related costs." This wording separates the cause, uncertain event and consequence. It is more actionable than a label such as "regulatory risk." The team should check the risk against drawings, bills of quantities, programme logic, procurement schedules, site logistics, contracts, permits, design interfaces and stakeholder decision requirements. A minimum identification workshop should include project management, planning, cost control, design, construction/site engineering, procurement, quality, safety/environment and contract or regulatory expertise as relevant. The team should invite subcontractor and supplier input where they control critical interfaces. Each risk entry should

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include a unique ID, source, affected work package, date identified, assumptions, existing controls, consequence dimensions and evidence source. A named owner should be assigned at the earliest practical point.

### 5.3 Scoring and prioritization protocol

Likelihood and impact should be rated separately before the product is calculated. The likelihood scale must refer to a defined period or project phase; "likely" is ambiguous unless the team states whether it means likely during the next month, before a milestone or at any time during the project. Impact should be assessed against the project's approved thresholds, not a general impression. Where impact spans multiple dimensions, the team should record the dimensions separately and use the maximum credible consequence or a project-approved aggregation rule. Averaging a severe safety consequence with a minor cost effect would be inappropriate.

The score $R = L \times I$ is used as an initial sorting index. The proposed bands in this paper—1–4 low, 5–9 moderate, 10–16 high, 17–25 extreme—are for demonstration only. They should be calibrated to the project context. A project may require different thresholds for life safety, environmental compliance, critical permits or contractual liquidated damages. Any mandatory escalation rule should override the product score. Scores should be accompanied by the component ratings, rationale, confidence level and source of evidence.

### 5.4 Risk response selection

| Response type | When it may be appropriate | Construction example | Evidence of completion |
|---|---|---|---|
| Avoid | Change plan or design to remove exposure where feasible | Resequence work to avoid a known flood-prone period, if technically and contractually viable | Approved revised programme/design |
| Mitigate | Reduce likelihood and/or consequence | Drainage preparation; early utility coordination; design clash reviews | Inspection record, updated rating, action closure |
| Transfer or share | Allocate a defined portion of financial or contractual exposure to a party better placed to manage it | Insurance, performance guarantees, fixed-price terms, risk-sharing clauses | Executed contract/insurance and clear residual-risk statement |
| Accept with contingency | Exposure is tolerable or further treatment costs more than expected benefit, with approval | Retain schedule float or budget reserve for a low/moderate residual risk | Approved acceptance, trigger, reserve and owner |

Response selection must account for side effects. Fixed-price contracts can reduce price uncertainty for a buyer but may increase supplier premiums or create disputes if scope is unclear. Accelerated construction can recover time but increase coordination and quality risks. Alternate sourcing can reduce dependency but may introduce qualification and inspection risks. Therefore, each proposed response should be checked for secondary risks and should not be regarded as complete until its implementation evidence is recorded.

### 5.5 Ownership, triggers and monitoring

A risk owner is the person accountable for ensuring that a response is planned, implemented and reviewed; the owner is not necessarily the person who performs every action. For approval delays, triggers might include a missed submission date, an authority query unresolved beyond an agreed period or an approval milestone approaching without confirmation. For steel-price escalation, triggers might include a supplier quotation expiring, a defined movement in a market index or a purchase order remaining unplaced by the procurement gate. For smart-system integration, triggers might include unresolved interface defects, failed test cases or late delivery of a critical component.

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Monitoring should compare inherent and residual risk. The register should retain original ratings, current ratings, response status, trigger status, due dates and a brief reason for changes. A closed action does not automatically mean the risk is closed: the risk event may still occur, or the action may reduce only one consequence. Closure should require evidence that the exposure is no longer relevant or has fallen within the approved tolerance.

### 5.6 Governance and reporting

The project manager should review extreme risks frequently and ensure that treatment decisions are escalated to the sponsor or client where they exceed delegated authority. High risks should have documented response plans and regular review. Moderate risks may be monitored through routine package meetings, while low risks remain in the register if they could accumulate or interact with other events. These are proposed governance arrangements rather than universal thresholds. The appropriate cadence depends on project complexity, risk velocity and contractual obligations.

A useful dashboard should report more than the count of red, amber and green risks. It should show overdue actions, newly emerging risks, risks whose ratings increased, residual exposure, high-risk triggers, ownership gaps and risks with unresolved dependencies. Counts alone can mislead: a project may show fewer extreme risks simply because ratings were downgraded without evidence. Auditability and consistent scoring are therefore essential.

## VI. DISCUSSION

### 6.1 Contribution relative to the thesis

The supplied thesis's broad focus is the relationship between risk management strategies and project success in time, cost and quality. The present paper narrows the analytical lens to the process by which risks are identified, categorized, ranked and translated into responses. It uses the thesis's risk categories and examples while adding a more explicit scoring protocol, response ownership, escalation rules, monitoring triggers and data-quality caveats. This distinction helps avoid merely reproducing the first research paper's broad treatment of risk management outcomes.

The thesis's sample scoring table is especially useful because it preserves both likelihood and impact and gives a planned response for each example. The Chapter 4 list—budget overrun, scope creep, approval delays, resource unavailability and poor communication—also suggests that project governance and coordination deserve attention alongside technical hazards. However, these rankings should not be generalized to all Indian construction projects without evidence from a broader sample. Risk rankings depend on project type, location, procurement strategy, design maturity, contractual allocation and stage of delivery.

### 6.2 Practical value and limits of the P–I matrix

The P–I matrix has practical strengths: it is inexpensive, easy to communicate, compatible with workshops and helpful for prioritizing management attention. Its transparency improves when rating anchors and assumptions are documented. Yet its limitations must be acknowledged. Ordinal ratings may not support precise multiplication; risks with the same score may have different profiles; assessors may systematically underestimate unfamiliar or externally controlled events; and aggregation can conceal interactions. The matrix should be the start of decision-making rather than the final authority.

Where project stakes are high or ratings are highly uncertain, teams should consider sensitivity analysis, scenario analysis or quantitative methods such as Monte Carlo simulation. Simulation does not automatically make the model correct; it requires plausible input distributions, dependency assumptions and validation. Its value is that it can represent uncertainty and correlations more explicitly than a single score [7]. Multi-criteria approaches may also be useful when risk dimensions conflict or when stakeholders have different preferences, but their complexity should be justified by the decision context.

### 6.3 Implications for Indian construction projects

The thesis's case material highlights environmental conditions, permit dependencies, market volatility, resource availability and technology integration. These are plausible areas for structured review in many projects, but their relative importance cannot be inferred from the illustrative table alone. For Indian construction teams, the framework

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can be adapted to local monsoon patterns, utility relocation, state and local approvals, supply-chain conditions, labour availability and contractual arrangements. It should be applied with project-specific evidence rather than assuming one national ranking fits all regions and project types.

A further implication is that risk management should be connected to ordinary project controls. The permit register should align with the baseline schedule; procurement risks should be visible in cost and delivery forecasts; design risks should connect to drawing and interface registers; and quality risks should be linked to inspection and test plans. This integration reduces the chance that the risk register becomes an isolated document maintained only for reporting.

### 6.4 Research integrity and interpretation of the source thesis

Critical use of the thesis requires distinguishing between proposed methodology, case narrative, illustrative tables and verified observations. The thesis contains statements about a mixed-methods design and sample sizes, but the material reviewed for this paper does not provide enough underlying evidence to independently reproduce the reported survey or statistical results. The paper therefore does not assert that 300 completed surveys or 20–25 interviews were independently analysed here. Nor does it treat the thesis's displayed risk scores as validated measurements. A publishable empirical extension would need a transparent sampling frame, questionnaire, response rate, data cleaning procedure, rating definitions, reliability checks, analysis code or reproducible calculations, and documentation of case-study permissions where relevant.

This distinction does not make the thesis unusable. It means its content is used responsibly as the source of a conceptual case and as the basis for a framework, while claims requiring independent evidence are limited. Clear provenance strengthens rather than weakens the resulting research paper.

## VII. RECOMMENDATIONS

First, establish a project-specific risk breakdown structure before the first major planning gate and include technical, schedule, cost, quality, operational, environmental, stakeholder and legal/regulatory sources. Second, standardize scoring anchors and train assessors to distinguish likelihood from consequence. Third, keep component ratings and evidence alongside the product score. Fourth, introduce mandatory escalation for safety, environmental, statutory and catastrophic risks regardless of the product. Fifth, assign a named owner and a due date to every high or extreme response. Sixth, link risk triggers to programme, procurement, cost and quality controls. Seventh, review residual risk after treatment and record evidence before closing actions. Eighth, maintain a lessons-learned record so that the risk checklist improves over successive projects.

For researchers, the next step should be an empirical validation study involving multiple construction projects. The study could gather ratings from project managers, engineers, contractors, consultants and clients; report sample selection and response rates; test inter-rater agreement; compare P–I rankings with observed schedule/cost/quality outcomes; and perform sensitivity analysis. If sufficient data exist, it could compare simple $P \times I$ rankings with weighted multi-criteria or simulation-based methods. The research should predefine its scoring thresholds and avoid presenting expert opinion as observed probability.

## VIII. LIMITATIONS AND FUTURE RESEARCH

This paper is limited by its dependence on a single supplied thesis and by the absence of raw project records or survey data that could be independently reanalysed. The named residential township, budget, schedule and risk scores are treated as thesis-reported case material rather than externally verified project facts. The priority bands and scoring anchors are proposed for demonstration and require calibration before operational use. The framework has not been validated against completed-project outcomes, and no causal claim is made that any particular response reduces delay, cost or defects by a quantified amount.

Future work should collect primary data from a clearly defined population of construction professionals and projects, separate inherent and residual risk, define impact thresholds by consequence dimension, and test the stability of risk rankings. Longitudinal data could reveal whether high-rated risks actually materialize and whether mitigation actions

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reduce their consequences. Further work could compare expert consensus, risk matrices, fuzzy methods, multi-criteria decision analysis and simulation approaches. Research should also examine risk ownership, escalation behaviour and whether the risk register is genuinely used in decisions rather than maintained as a compliance artifact.

## IX. CONCLUSION

Construction risk identification and prioritization are most useful when they lead to decisions rather than simply produce a ranked list. Drawing on the supplied thesis and established literature, this paper proposes a transparent process that connects risk identification, classification, probability–impact scoring, priority bands, mandatory escalation, mitigation planning, ownership and monitoring. The thesis's examples—such as budget overrun, scope creep, approval delays, resource unavailability, utility relocation, price escalation, design coordination and monsoon flooding—illustrate how the process can be applied to construction risks with different sources and consequences.

The probability–impact product offers a practical first-pass sorting mechanism, but it should not be mistaken for a precise quantitative measure. Its usefulness depends on clear rating definitions, documented evidence, multidisciplinary review and explicit treatment of high-consequence risks. The framework should be integrated with programme, cost, procurement, design, quality and compliance controls and updated as conditions change. Because the underlying thesis material does not provide sufficient raw data for independent verification, the case scores are treated as illustrative or thesis-reported rather than validated findings. The principal contribution is therefore a structured, auditable framework suitable for practical adaptation and future empirical testing.

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