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Data-Driven Risk Visibility for Construction Lenders

Madhan kumar J, Kranti Kumar Myneni

***Abstract:** This research aims to create a structural base for institutional investors to effectively monitor investment risks associated with residential construction projects in India under RERA regulations. Under prevailing scenarios, institutional financing bodies periodically evaluate the associated risks of construction projects, often with the support of due diligence reports from consulting firms. To effectively address existing challenges, this research aims to develop a consolidation platform to implement recent advancements in global risk-monitoring standards, including Bayesian networks, system dynamics, earned value management, and value-based control systems, within a proposed integrated system comprising five layers. This proposed idea has been supported by a literature review, data analysis, and further validation of the findings using the Tamil Nadu RERA data portal for residential construction projects in Chennai, Tamil Nadu, India. This research is significant for stakeholders in India's construction finance ecosystem and provides practical validation of the theoretical correctness of risk monitoring.*

***Keywords:** Risk Monitoring, Bayesian Networks, Construction Finance, Rera, Dynamic Risk Assessment, Lending Governance, Project Lifecycle Monitoring, Data Integration, Decision-Support Systems.*

Nomenclature:
FST: Fuzzy Set Theory
AHP: Analytic Hierarchy Process
MCDM: A robust Multi-Criteria Decision Making
BN/DBN: Bayesian Networks and Dynamic Bayesian Networks
DAG: Directed Acyclic Graph
BIM: Building Information Modelling
BIS: Bank Investment Supervision
RERA: Real Estate Regulatory Authority

I. INTRODUCTION

The Indian residential construction industry is an important sector for domestic capital investment. However, it is also exposed to several risks associated with regulation, execution, finance and operations. Some common risks include delays in project completion due to insufficient approvals, design changes, cost overruns, and regulatory issues. These risks often result in project delays and affect the borrower's ability to repay the loan.

For institutional lenders such as commercial banks, housing finance companies, and non-banking financial corporations, these risks increase the risk of loan default and make it difficult to estimate collateral value. The Real Estate Regulatory Authority (RERA) regime, which came into effect in 2016, has brought major changes to the industry, with increased transparency through standardised project registration, disclosure, and reporting requirements. However, despite this change, financial institutions still lack a comprehensive technological platform that integrates operational data with financial risk parameters. At present, leading investment risk monitoring companies such as JLL and CBRE do not have standardised procedures or monitoring platforms for their lender clients. When lenders approach these companies for project analysis before loan disbursement, the entire analysis is still carried out manually, and the criteria for project analysis are highly variable. This often results in lenders receiving inconsistent analysis results, and early warnings of financial or operational risks go undetected until they become a threat to project viability.

This gap in operations and analysis underscores the need for a structured, data-driven, ongoing risk-monitoring system specifically designed for institutional lenders in India's RERA-regulated construction finance landscape.

II. PROBLEM STATEMENT

The traditional risk assessment approach employed by lending institutions has two major and interrelated flaws. First, the risk assessment is often static and conducted periodically, relying almost exclusively on documents available at the time of loan origination and not updated since. Second, the risk assessment fails to effectively address the changes in risk over the long project life cycle. This problem is compounded by the fact that monitoring bodies and consultants conduct due diligence manually, without standardised procedures. Each consultant employs different procedures, resulting in discrepancies in risk assessment due to individual interpretation and data availability. This leads to substantial discrepancies in the risk assessment output. Lenders thus face two interrelated problems: comparing risk profiles across projects and monitoring risk over time.

The absence of real-time monitoring tools that integrate data and standardised governance dashboards means that important warning flags, such as regulatory delays, construction problems, cash flow issues, and escrow account discrepancies, are often missed until they have substantially affected the project's viability and the lenders' recoverability. This study seeks to address this problem by developing an integrated monitoring framework that aggregates regulatory, project-execution, and financial data to provide lenders with standardised, real-time risk-exposure assessments.

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*Correspondence Author(s)
Madhan Kumar J, Department of Master's in Building and Engineering Management, School of Planning and Architecture, Vijayawada (Andhra Pradesh), India. Email ID: madhankumar2404@gmail.com
Dr. Kranti Kumar Myneni*, Department of Masters of Building and Engineering Management, School of Planning and Architecture, Vijayawada (Andhra Pradesh), India. Email ID: kranti.myneni@spav.ac.in, ORCID ID: 0000-0002-0753-5636

A. Bank Monitoring of Construction Loans: Lender-Oriented Risk Perspective

To put it simply, construction lending is at the higher end of the risk spectrum in institutional financing, as the assets underlying it do not become reality until construction is complete. Unlike regular mortgage loans, which are secured from the outset, construction loans are based on assets that become reality only when construction is complete, which increases the risk of errors, regulatory issues, and behavioural risks.

Basically, the challenge with construction financing lies in managing the time lag between the release of funds and the point when the asset is either usable or salable. Funds are released in sequence, but the borrower's capacity to repay depends on the project's completion, delivery to market, or a successful refinance. There is no consistent cash flow during construction, increasing the lender's sensitivity to precise execution and budgetary control. Any degree of delay, quality, or cost-control problems is a strong indicator of risk and reduces the probability of a successful payback.

To address these risks, the lenders apply structured monitoring techniques that are expected to minimise information gaps at various stages of the projects' life cycles. While due diligence is conducted in the initial stages to test the feasibility of the projects, their regulatory suitability, cost estimates, and the developer's track record, the actual risks are known only during disbursement. Changes in project conditions, regulatory delays, and execution inefficiencies are often beyond the predictive capabilities of loan approvals.

Ongoing monitoring is thus a cornerstone of construction loan governance. It involves constant monitoring of the project sites and disbursing funds based on progress made on each site. This is achieved by tethering the disbursement of funds to project milestones. In this way, it serves as a risk management method. It allows lenders to disburse funds to sites in conformity with the project milestones.

Quite often, monitoring agencies are engaged to provide unbiased information on progress, quality, and adherence to approved plans. These monitoring agencies usually submit detailed reports to support informed decisions on fund disbursement, increased monitoring, or the involvement of credit risk committees. Deviations that monitoring might identify might entail increased inspection frequency.

The level of monitoring could vary across projects depending on the level of risk. For example, depending on experience, the amount of leverage the project represents, whether it is speculative or pre-committed, and exiting banking relationships, all of which can affect how closely a project is monitored. In environments characterised by more uncertainty or weaker borrowers, monitoring becomes even more judicious. On the other hand, when a relationship develops, monitoring can become less intensive as trust builds. Studies on finance in the construction sector have consistently shown that the key to loan performance lies in monitoring. The greater the vigilance in the project loan, the greater the chance of preventing the project from going out of control. For lenders, the need to monitor cannot be taken lightly, as the process is directly linked to good corporate governance.

Still, there is a tendency for traditional monitoring of construction loans to be largely qualitative, consultant-dependent, and compartmentalised. The lack of standard measures, live information feeds, and a mechanism to aggregate probabilistic information on various risks that are building up has meant that lenders require a structured, data-centric approach to monitoring that integrates a multitude of information, whether it relates to regulations, execution, or finances.

B. The Three Key Reporting Stages

Under the Bank Investment Supervision (BIS) framework, the bulk of monitoring work is typically centred on the following three key reports, each with a specific focus.

i. Initial Report:

This report is made before the start of any major construction work. This is the final feasibility check for the plan. The inspector will check for all necessary permits, determine whether the project's funding and schedule are feasible given current market conditions, and verify that the construction plan is consistent with the design.

ii. Monthly Reports:

This involves ongoing check-ups throughout the entire construction period. The inspector inspects the site to assess physical progress against the planned schedule, the quality of work, and any major changes. This plays a major role in the entire monitoring process.

iii. Final Report:

This report is generated upon the conclusion of the project. It serves as assurance that the completed building resembles the one originally projected, budgeted for, and scheduled in accordance with the budget.

Table I: Risks Significance – Phase P of Projects Preparation and Design Works

No.	Significant Risks at the Preparation & Design Works Phase P	Impact [0;1]	Likelihood [0;1]	Significance [0;1]
1	Delayed agreements and environmental decisions	1.0	0.3	0.30
2	Building Permit Design is non-compliant with the Act of Building Permit Design Scope and Form	1.0	0.1	0.10
3	Protest against Building Permit	1.0	0.1	0.10
4	Unconfirmed Investor's Own Equity	1.0	0.2	0.20
5	Inconsistent administrative building decisions	0.5	0.4	0.20
6	Irrational procurement process for construction works	0.2	0.1	0.02
7	An incorrectly structured budget for construction works	0.7	0.2	0.14
8	Unappropriated level of budget contingency	0.3	0.4	0.12
9	Improperly calculated break-even point of the project	0.5	0.1	0.05
10	Unbalanced parameters of Cost – Time – Quality within the agreement for construction works	0.6	0.2	0.12

Table 1. Risk Significance – Phase P of the Project Preparation and Design Works. Source: [3]

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C. What an Inspector Looks for

On-site, the examiner serves as a fact-finder for the bank and is expected to be impartial. Their primary responsibilities are:

- Positive draw certification by the borrower, which involves verifying their draws to ensure the amount they represent actually reflects the work completed for payment.
- Determine the current progress of the project compared to the approved construction schedule to determine whether any delays exist.
- To record the quality of workmanship to check whether it follows the architectural designs and building standards.
- Identifying potential problems: peruse the key documents, such as the construction log, for entries that could potentially point to future problems. This information flow is sourced from the field. It feeds into the bank's real-time control mechanism, which decides whether to release or withhold funds.

D. From Information to Action: Approving and Denying Funds

The monitoring data remains active as it's collected, affecting the bank's decisions, particularly regarding the release of funds for lending.

i. The Draw Request Cycle

A borrower initiates this process by submitting a draw request to fund completed work as the project progresses. This draw request initiates a site check. In construction loans, draw schedules are invariably fixed. This way, progress is benchmarked before more funds are exposed. The banker isn't going to release the next draw unless it is confident of seeing progress on the project.

ii. The Power of the Inspector's Report

The first source of evidence that guides bank funding decisions is the inspector's report. We see a direct connection between these reports and the bank's actions. An analysis of 143,074 reports revealed the following:

- More negative wording is used, as seen in reports, which directly translates into the likelihood of the bank rejecting the draw request.
- More positive words in the report increase the likelihood that the draw will be approved.

This pattern demonstrates that banks use qualitative monitoring data to make real-time financial decisions, with borrowers held accountable for the project plan. This linkage between monitoring and financial control leads us to ask the bank: How does the bank most efficiently allocate its monitoring resources? Yet another interesting result is that prior relationships with the borrower or the contractor are associated with lower monitoring. It might seem odd that prior relationships would decrease monitoring. However, this is simply another reflection of the fundamental idea that information is capital. If the banker has a prior history with the borrower or the contractor, then the banker can "rely upon its information capital that the borrower is reliable." In other words, information that the banker spent resources accumulating is now available "at virtually no marginal cost." This emphasis on the control and refinement of monitoring prompts an important question for all risk management activities: Does the extensive, costly effort really make a difference?

E. Calibrating the Watch: What Drives Monitoring Intensity?

Since monitoring is expensive, how does a smart bank strategically spread its limited monitoring resources? Banks do not monitor all loans with the same intensity; they adjust the frequency and timing of inspections based on a trade-off between monitoring costs and the perceived risks of the loan. Research shows that several key factors drive this calibration. Key Factors Influencing Monitoring Levels

Table II: The Insight on Banking Relationships

Factor Category	Specific Factor	Impact on Monitoring
Borrower & Project Risk	Borrower with a low credit (FICO) score	More Intense Monitoring
	Project with a high combined loan-to-value (CLTV) ratio	More Intense Monitoring
	"Speculative" project (built to sell, not for a pre-committed buyer)	More Intense Monitoring
	"Owner-builder" (borrower with little construction experience)	More Intense Monitoring
Loan Terms	Lower interest rate or fees (loan spread)	More Intense Monitoring
Bank Relationship	Borrower has a prior loan history with the bank ("repeat borrower")	Reduced Monitoring
	Contractor has a prior history with the bank ("repeat contractor")	Reduced Monitoring

Table 2: The Insight on Banking Relationships, Source: Author

F. The Bottom Line: Does Monitoring Prevent Loan Defaults?

Banks provide watchful care over loans as part of risk management, but the question remains: do such efforts enhance loan performance? The answer is obvious from the following:

i. The Causal Link

Demonstrating the direct cause-and-effect relationship between monitoring and loan outcomes is difficult because of endogeneity concerns—do banks tend to monitor riskier loans to begin with, or does monitoring actually reduce risk? Robust scholarly work has successfully addressed these issues using an IV approach to measure the effect of proper monitoring. The main takeaways are:

- The more bank monitoring, the better the correlation with a significant drop in default risks.
- In the IV setup, when monitoring increases by one standard deviation, the probability of default falls by 5.59 percentage points [2].

So What? For Banking Students, the importance of this outcome is that it provides empirical evidence for the "core" theories of banking. It serves as confirmation that banks have a clear advantage in providing credit—namely, the ability to limit moral hazard through "hands-on" monitoring. This is not just window dressing—it is the core of lending, with the potential to greatly enhance the quality of the bank's credit portfolio. Having the process and impact in mind, it is possible to extract these lessons into a few general principles.

G. Key Takeaways on Construction Loan Monitoring

For any person starting in finance or banking, observing how banks manage construction loans is one of the first and best lessons in risk management. The gist boils down to three general ideas.

- *Direct Monitoring Addresses the Peculiar Risks:* Construction loans are peculiar in the sense that the collateral takes shape only during the course of the project, and there is no initial cash flow. This, therefore, creates a serious moral hazard. An active, on-the-ground inspection is the bank's primary tool for managing risk.
- *Information Guides Decisions:* Inspection is not a passive process. The information in the inspection report helps banks make critical, timely funding decisions. A bad report can halt disbursement; a good one can keep the project moving.
- *It Pays off:* The evidence is clear. Rigorous monitoring is not bureaucracy; it's a proven practice that reduces the odds of loan default and underlines its vital role in sound banking.
- *In the end, Construction Loan Monitoring is a key way to Reinvest in Perhaps a Basic Banking Principle:* proactive information-based risk management is not a cost but a major enhancer of portfolio quality and institutional value.

III. IV. EVOLUTION OF RISK MODELING AND ASSESSMENT METHODOLOGIES

Leadership and risk management are key determinants of success, especially in large scientific, engineering, and capital-intensive ventures. The story of how we evaluate construction risks has changed significantly over time, advancing from variety estimates to multi-attribute approaches.

A. Paradigmatic Shift: From Estimation Variance to Project Attribute

In earlier periods, analysing risks in a project essentially meant measuring changes or variances, with heavy reliance on probability theory. A classic example is PERT, or Program Evaluation and Review Technique, developed in the 1950s to manage uncertainty and predict how long a given project would take to complete. However, in the 1980s, risks came to be considered a function or attribute of a project, rather than a measurement function. The first approach to considering risks as a function or attribute was the Probability Impact Matrix, which arranges risks by likelihood of occurrence and potential impact.

B. Quantitative Techniques for Complexity and Subjectivity

As the levels of subjectivity and complexity were better appreciated in the construction risk process, more advanced analysis tools were employed:

- *Fuzzy Set Theory (FST):* FST is proposed for dealing with the subjective aspects associated with risks, which involves linguistic terms and their membership functions. FST is considered useful for the construction field, where precise numerical expressions may not be possible.
- *Analytic Hierarchy Process (AHP):* A robust Multi-Criteria Decision Making (MCDM) technique that arranges intricate decisions and expresses judgment quantitatively. AHP is commonly used to prioritise risks across different classes. It is also used to assess Building Information Modelling (BIM) competencies [1].
- *Fuzzy AHP Integration:* Where fuzzy and AHP methodologies are compromised to create an even more robust tool. This is especially important in joint ventures, where risk perceptions may diverge.
- *Bayesian Networks and Dynamic Bayesian Networks (BN/DBN):* Probabilistic models that encode cause-effect relationships and update over time based on the receipt of monitoring data. These approaches are designed to facilitate perpetual risk assessment, not one-time analysis. Key characteristics are:
- Their involvement in dynamic monitoring structures, which include both Risk Registers and Project Time Networks. - Their application in the risk analysis of the costs of the lifecycle of an infrastructure, adapting the structures of the networks according to certain kinds of causality. - Their utilisation in the context of Dynamic Bayesian Network configurations for cost risk investigation within the production, transportation and construction phases.
- Process mining thus adds an advantage to the processes of risk management because it helps to detect, monitor and analyse risks by tracing processes through actual events such as log files of risks and changes. This is a remedy for the shortcomings of traditional risk management approaches. Traditional risk management methods do not account for the interconnectedness of risks. They are also subjective due to insufficient data. Moreover, it is difficult to monitor process progress using traditional approaches.

IV. FUNDAMENTAL CHARACTERISTICS OF BAYESIAN NETWORKS

Bayesian Networks are probabilistic models that show how variables are associated with and dependent on one another. It uses a data structure called a Directed Acyclic Graph (DAG), where each node represents a probabilistic variable, and arrows indicate dependencies between variables.

$$P(X_1, X_2, \dots, X_n) = \prod_{i=1}^{n} P(X_i \mid \text{Parents}(X_i))$$

This breakdown enables efficient probability calculation, even in complex scenarios, by leveraging conditional independence relationships.

The strength of the BN model lies in its data-learning capabilities and its ability to infer and calculate probabilities from newly presented evidence.

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However, as the BN methodology relies heavily on the initial input, the accuracy of its predictions would be only as good as the quality of the initial data [4]. BBNs can be easily used to assess and compare the effects of various mitigation measures and to support the design process of the monitoring system [5].

A. Relevant Extensions for Construction Risk

For construction lending, two extensions stand out as particularly worthwhile:

i. Dynamic Bayesian Networks (DBNs)

These are an extension of Bayesian networks and are useful for understanding the evolution of things over time. They show the evolution of variables across different stages over time. They are useful for "watching" risk evolve through the various stages of a project."

ii. Hybrid Bayesian Networks:

These models include both discrete and continuous variables, enabling the integration of categorical information (such as approval status) and continuous considerations (such as cost performance indicators).

V. COMPARATIVE ANALYSIS: BAYESIAN NETWORKS VERSUS ALTERNATIVE METHODOLOGIES

A. Traditional Risk Assessment Methods

i. Probability-Impact Matrices:

They're easy to understand and popularly used, but ultimately, these kinds of matrices are static. They do not suggest how the results can be changed or show how the factors interact with each other.

- Checklists and Scoring Systems: These provide standardised methods of evaluation. They are slow to incorporate new evidence but do not readily consider cause–and–effect relationships.
- Expert Judgment Systems: Grounded in human intuition, it provides useful insight but is subject to cognitive biases, as well as having little quantitative basis.

Table III: Synthesis of Comparative Advantages

Criterion	P-I Matrix	Fuzzy AHP	System Dynamics	Machine Learning	Bayesian Networks
Dynamic Updating	Poor	Moderate	Good	Good	Excellent
Causal Modeling	Poor	Moderate	Good	Poor	Excellent
Uncertainty Handling	Poor	Good	Moderate	Good	Excellent
Interpretability	Excellent	Good	Good	Poor	Excellent
Data Requirements	Low	Moderate	High	Very High	Moderate
Computational Efficiency	Excellent	Moderate	Poor	Variable	Good
Regulatory Compliance	Good	Moderate	Moderate	Poor	Excellent

Table: Methodological Comparison for Construction Risk Monitoring, Source: Author

VI. CORE JUSTIFICATIONS FOR BAYESIAN NETWORK SUITABILITY

A. Alignment With Construction Risk Characteristics

Construction projects have risks that, in four core characteristics, can be effectively addressed using Bayesian networks:

i. The Dynamics of How Things Evolve:

The risks are dynamic; they are not static; they evolve from the beginning to the end of the project. Regulatory issues in the early stages may delay project execution and affect the budget. Dynamic Bayesian networks account for all these dynamics.

ii. Interdependent Factors:

Delays in obtaining approvals will cascade through the schedules, then the costs and finance implications. The graph structure of a Bayesian network directly supports the modelling of cause-and-effect relations.

iii. Information Uncertainty:

Monitoring progress involves several unknowns, such as the availability of RERA data, the uncertainty of progress expressed as a percentage, and the uncertainty of the completion date. Bayesian networks are useful here.

iv. Mix of Data Types:

The system collects category-based data (approval status), ordinal-based data (risk levels) and continuous data (financial data). Hybrid Bayesian networks can efficiently handle these different data types.

B. Dynamic Updating Capability

The fundamental BN mechanism of belief updating via Bayes' theorem addresses a critical limitation of traditional methods. A DBN can be decomposed into multiple SBNs and transmission networks between adjacent time slices [6]:

$$P(H \mid E) = \frac{P(E \mid H) \cdot P(H)}{P(E)}$$

Where:

- $P(H|E) $ = Posterior probability of hypothesis H given evidence E
- $P(H) $ = Prior probability of H
- $P(E|H) $ = Likelihood of evidence E given H

In practice, as new RERA data arrives (e.g., delayed approval notifications), the system automatically updates the probabilities of related risks (e.g., schedule delays, cost overruns).

C. Causal Reasoning for Root Cause Analysis

BNs allow for a few fundamental reasoning methods that are critical for good risk management:

i. Predictive Inference:

How likely is default given the regulatory delays currently in place?

ii. Diagnostic Inference:

If the project is being delayed, which regulatory issues are likely causing the problem?

iii. Intercausal Inference:

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When we observe financial stress, how should we update our beliefs about execution problems? This multi-directional approach by the lender enables it to anticipate problems and identify precisely where they originate.

D. Handling Incomplete and Imperfect Data

The monitoring of construction risk in India faces several challenges, including.

i. Missing quarterly RERA reports
ii. Inconsistent data formats across different state portals
iii. Information from several sources that is in conflict
iv. Combination of qualitative expert judgments and quantitative metrics

BNs offer practical ways to address the following issues:

- Partial incorporation of evidence: modify the probabilities given only partial observations
- Sensitivity analysis: determine which missing data would have the greatest impact on improving predictions
- Soft evidence: allow uncertain or probabilistic observations to be used - Integration of expert knowledge: Using prior probabilities and network structures reflecting expert views

E. Regulatory Compliance and Auditability

BN models meet the major requirements of regulated financial organisations through their transparency and auditability. While traceability is available in BN model decision-making, unlike in black-box ML models that are unexplainably traceable, BN-derived decision results are already traceably explainable. From the initial data set through the entire decision-making process to the final set of recommendations, everything is fully traceable and explicable. Both the structures of the BN models and their parameters are fully examinable by the experts.

VII. FRAMEWORK IMPLEMENTATION AND GOVERNANCE INTEGRATION

A. Implementation Architecture

i. Regulatory Monitoring Layer:

This layer helps to maintain a steady pulse on regulatory milestones, approval status and compliance signals. This layer injects the main framework with the latest information on the changing nature of regulatory risks.

ii. Execution Monitoring Layer:

Here, the health of projects is monitored through measurements such as cost and schedule performance indices, as well as resource utilisation. All these factors are related to the execution risk dimension.

iii. Financial Integration Layer:

At this layer, we study cash flows, the disbursement rate and escrows. Financial risks are addressed at this layer, which interfaces with financial management systems.

iv. Probabilistic Risk Integration Layer:

A Bayesian Network integrates data from all layers, namely the regulatory, execution, and financial layers. It incorporates new information in real time and updates probabilistic risk calculations accordingly, producing an overall risk score.

v. Governance Response Layer:

Governance procedures give effect to risk findings through actions like:

- Disbursement Authorisation Levels
- Increasing the frequency of monitoring high-risk projects
- Activating EARLY INTERVENTION TRIG
- Implementing steps for escalating risks where overall risks are increasing

VIII. CONCLUSIONS

This study shows that the management of investment risks in Indian residential construction finance cannot be addressed by static, document-intensive measures carried out at the point of loan sanction or during infrequent reviews. The management of these risks by integrating the various regulatory, execution, and financial risk dimensions into a single dynamic process facilitates the shift towards continuous risk management in the database. Basically, the results indicate that the existing methods, which include the use of various consultancy reports and infrequent use of real-time data, cannot offer effective management.

The main contribution is an integrated system encapsulated within a systematic five-layer framework based on probabilistic reasoning, drawing on data from RERA regulations, project management measures, and financial data. The systematic design, based upon a mixed-methods design involving literature review, evaluation of bank monitoring practices and conceptual modelling, is said to propose an effective method to update risk scores in light of new data, as provided by tools such as Bayesian Networks, Dynamic Bayesian Networks, Earned Value Management, system dynamics modelling, Monte Carlo simulation and process mining techniques.

Conceptually, the work helps explain the relationships among regulatory risks (approval risks, RERA reporting inconsistencies), execution risks (cost, time, and quality risks), and financial risks (cash flow tensions, delayed payments, escalating exposure). The five-layer model, which incorporates regulatory, execution, financial, composite risks, and the governance component, defines the pathways through which data flows from the project site to lenders' governance decisions. The framework allows for early warning systems, monitoring and intervention. The model also provides a common language and a set of indicators for the dashboards used by bank investment oversight and internal credit risk teams. There are several potential advantages to lenders and regulators from the proposed framework. These could include standardising due diligence, monitoring projects, making comparisons, and reducing dependence on experience-based intuition. Also, to a certain degree, there could be a better appreciation of how transparency and standardised reporting can significantly improve the overall effectiveness of lender risk assessment exercises by linking them to RERA portals. Further, the study presents, to a great extent, not only the theoretical possibilities but also the practical opportunities to integrate spatial analysis, dashboards, and the monitoring procedures adopted by banks into a probabilistic framework for risk assessment.

However, one cannot ignore the caveats associated with the

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current work. The model has not been empirically verified and has remained conceptually valid, which needs to be assured in the context of an operational banking system. Emphasising RERA-registered residential projects conducted within Chennai limits restricts the generalizability of the model results. Bayesian network quantification and other sections would require institution-specific data, policies and past performance, which may not be publicly available. Given that the framework is based on observed practices in bank lending and secondary data, certain segments of bank behaviour can be inferred only.

As for future directions, several avenues for improvement may be considered. Firstly, implementing a pilot of this framework within a lending institution or a monitoring agency would test its overall practicality. Secondly, the inclusion of more digital inputs, such as BIM-based progress assessments, construction site visualisations, and bank workflows, could improve the objectivity of risk assessments. Thirdly, expanding this study to cover several states and data from multiple RERA portals could enable benchmarking of regulatory practices and the refinement of indicators to account for differences in disclosure quality and enforcement.

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AUTHOR'S PROFILE

Madhan Kumar J, a postgraduate scholar currently pursuing a Master's degree in Building Engineering and Management at the School of Planning and Architecture (SPA), Vijayawada, Andhra Pradesh, India. My academic training has provided me with a strong foundation in construction management, construction finance, project monitoring, and regulatory compliance, with a particular emphasis on risk assessment and governance in real estate and infrastructure projects. My primary research interests focus on monitoring investment risk in construction finance, especially in RERA-regulated residential developments in India. I am particularly interested in applying probabilistic and data-driven methodologies, including Bayesian Networks, Dynamic Bayesian Networks, Earned Value Management, system dynamics, and process-oriented risk analytics, to enhance transparency, early-warning capabilities, and decision support for institutional lenders. My current research explores integrating regulatory disclosures, project execution metrics, and financial performance indicators into unified monitoring frameworks that support continuous lender oversight throughout the project life cycle. I have been actively engaged in conceptual research, systematic literature review, and framework development related to Construction and finance management practices. My work aims to bridge the gap between traditional, document-based due diligence approaches and modern, evidence-based risk-monitoring systems that support governance and credit decision-making. I am particularly motivated to develop research outputs that demonstrate practical relevance for banks, housing finance institutions, monitoring agencies, and regulatory stakeholders. In addition to my academic coursework, I have participated in seminars, technical discussions, and research-oriented activities related to construction finance, sustainability, and infrastructure governance. My academic achievements reflect a consistent commitment to analytical rigour and research-driven inquiry. My long-term professional objective is to contribute to advanced research and practice in project management, construction finance, investment risk management, and infrastructure governance, with aspirations toward doctoral research and policy-relevant roles that support resilient and transparent construction and real estate finance systems.

Dr. Kranti Kumar Myneni received a B.Arch degree from JNTU, Hyderabad, Telangana, India in 2001, pursed Masters (M.Sc. - Construction Management) from South Bank University, London in 2003 and received a doctorate from the School of Planning and Architecture, Vijayawada. Currently working as an Assistant Professor in the School of Planning and Architecture, Vijayawada. Member of the Council of Architecture and a Fellow member of the Indian Institute of Architects. Published nearly 40 articles and presented papers at 5 international conferences.3 chapters