

Artificial Intelligence-Enabled Construction Contract Management for Reducing Legal Disputes and Project Risks: A Comprehensive Literature Review

Dr. Muhammad Shoaib Ahsraf¹, Dr. M. Adil Khan², Saud Faisal Farooq³, Hammad Abdullah⁴, Abdul Wahab⁵, Abdullah⁶

¹ Senior Program Manager, Mecaer America Inc., 5555 Rue William-Price, Laval, Quebec, Canada., Email: m.ashraf@mecaer.ca

² Resident Engineer, NESPAK., Email: adee.uol@gmail.com

³ UET Peshawar., Email: Saudfaisal11@yahoo.com

⁴ CECOS University of IT and Emerging Sciences., Email: hammadabdullah04@gmail.com

⁵ Department of Construction Engineering and Management, NUST., Email: m.abdulwahab.mce@gmail.com

ORCID: 0009-0004-0255-707X

⁶ University of Engineering and Technology, Peshawar , Email: civilengrabdullah1@gmail.com

Corresponding author: Dr. M. Adil Khan, adee.uol@gmail.com

Abstract: Construction projects worldwide face persistent challenges related to contract disputes, cost overruns, and schedule delays. This review synthesizes current research on artificial intelligence (AI) applications in construction contract management, examining how machine learning, natural language processing, and blockchain technologies reduce legal disputes and mitigate project risks. Through systematic analysis of 40+ peer-reviewed studies, we identify four key AI implementation domains: contract analysis and review, dispute prediction and prevention, risk identification, and payment automation. Machine learning algorithms achieve up to 98% prediction accuracy in dispute forecasting, while NLP-based systems reduce contract review time by 76%. Blockchain-enabled smart contracts accelerate payment cycles from weeks to minutes. However, implementation barriers persist, including data quality requirements, integration complexity, and regulatory uncertainty. This review proposes an integrated socio-technical framework combining AI with BIM, blockchain, and governance mechanisms for effective deployment. Future research must prioritize standardization, explainability, and ethical AI frameworks to maximize benefits while minimizing legal and technical risks.

Keywords: Artificial intelligence, construction contracts, dispute resolution, machine learning, legal technology, blockchain, risk management, natural language processing

1. Introduction

The construction industry generates significant economic value, contributing nearly \$1.2 trillion to the U.S. economy alone, yet faces systemic challenges that undermine efficiency and stakeholder relationships (Siswahyudi et al., 2025). Construction disputes represent one of the most persistent obstacles, with litigation costs consuming substantial resources and extending project timelines by months or years (Francis et al., 2025). Poorly managed contracts lead to payment delays, cost overruns averaging 15-30%, and fractured relationships between contractors, owners, and consultants (Gamage, 2025). Traditional dispute resolution mechanisms—litigation and arbitration—require two to six years for resolution, with expenses that often exceed the disputed amounts themselves (Mahfouz &



Kandil, 2011). These systemic inefficiencies highlight the critical need for innovative approaches to contract management and legal decision-making in construction.

Artificial intelligence has emerged as a transformative technology across multiple industries, and the construction sector increasingly recognizes its potential to address legacy challenges (Fatima et al., 2025). The convergence of machine learning, natural language processing, and blockchain technologies creates unprecedented opportunities for automating contract analysis, predicting disputes before they escalate, and executing payments transparently (Razi et al., 2026). Recent advances in deep learning and transformer-based models enable extraction of implicit legal knowledge from massive document collections, identifying risk patterns that human reviewers might miss (Hamzha et al., 2025). Simultaneously, blockchain technology provides immutable transaction records that enhance trust and reduce non-payment issues that plague the construction supply chain (J. Liu, 2025).

However, the adoption of AI in construction contract management remains fragmented and inconsistent. While leading organizations deploy advanced analytics platforms, regulatory uncertainty, integration complexity, and concerns about algorithmic transparency limit widespread implementation (Singh & Kumar, 2022). Most construction firms still rely on manual contract review processes vulnerable to human error and time constraints (Dikmen et al., 2025). Integration of AI with existing workflows—particularly Building Information Modeling (BIM) systems—remains underdeveloped despite complementary capabilities (Z. Liu et al., 2019). Furthermore, ethical considerations surrounding AI bias, data privacy, and accountability remain inadequately addressed in construction law (Guo, 2024).

This literature review synthesizes current knowledge on AI-enabled construction contract management, examining technological capabilities, implementation pathways, and barriers to adoption. We analyze how machine learning improves dispute prediction, how natural language processing automates risk identification, and how blockchain enables intelligent contract execution. By integrating findings across 40+ peer-reviewed studies published primarily between 2015 and 2025, we present a comprehensive framework for understanding this emerging field's opportunities and limitations. The review emphasizes that successful AI deployment requires not merely technological innovation but also legal adaptation, stakeholder engagement, and governance mechanisms that ensure fairness and accountability.

2. Methodology

2.1 Research Design and Search Strategy

This systematic literature review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure rigor and reproducibility (Francis et al., 2025). We conducted a comprehensive search across multiple academic databases—Web of Science, Scopus, and Google Scholar—using keyword combinations including "artificial intelligence construction contracts," "machine learning dispute prediction," "blockchain smart contracts construction," "natural language processing legal documents," and "AI risk management construction." The search was limited to peer-reviewed publications from 2015 onwards, capturing the emergence of AI applications in construction. All searches were conducted between September and October 2025, retrieving the most current research.

2.2 Inclusion and Exclusion Criteria

Inclusion criteria encompassed studies that: (1) addressed AI, machine learning, or deep learning applications in construction or legal contexts; (2) focused on contract management, dispute resolution, or risk management; (3) presented empirical data, case studies, or frameworks with quantifiable outcomes; (4) were published in English-language peer-reviewed journals or conferences. Exclusion criteria eliminated: (1) purely theoretical papers without empirical validation; (2) studies limited to other industries without construction applicability; (3) papers addressing only traditional dispute resolution without technological innovation. This approach yielded an initial pool of 187 publications, refined to 40+ studies meeting all criteria through title and abstract screening, followed by full-text review.

2.3 Data Extraction and Analysis

For each eligible study, we extracted: publication year, research methodology, AI techniques employed, construction domain (e.g., contract analysis, dispute prediction, risk identification), sample size, performance metrics, and reported outcomes. Studies reported accuracy rates, F1-scores, prediction precision, implementation timelines, and cost-benefit analyses. We categorized applications into four primary domains: (1) Contract Analysis and Review; (2) Dispute Prediction and Management; (3) Risk Identification and Assessment; (4) Payment Automation and Compliance. Quantitative data were synthesized to identify performance ranges, while qualitative findings were analyzed thematically to identify barriers, enablers, and future research directions.

2.4 Quality Assessment

Study quality was assessed using adapted criteria from the Cochrane Risk of Bias tool, evaluating: clarity of research objectives, appropriateness of methodology, adequacy of sample size, transparency of data sources, and validity of conclusions (Aikpokhio et al., 2024). Studies received quality ratings (high, moderate, low) based on these dimensions. High-quality studies (typically n > 100, clear methodology, validation procedures) were weighted more heavily in synthesis. Studies examining real-world implementations (case studies, pilot projects) were particularly valued for demonstrating practical applicability beyond theoretical frameworks.

2.5 Limitations

This review acknowledges several limitations. Publication bias may skew findings toward positive outcomes, potentially overestimating AI effectiveness. Geographic variation in research (China and U.S. represent >60% of publications) may limit generalizability to other construction contexts. Heterogeneity in methodologies, outcome measures, and implementation contexts complicated direct comparison of findings. Many reviewed studies remain at proof-of-concept stage, with limited longitudinal data on sustained real-world impact.

3. Results

3.1 AI Applications in Construction Contract Management

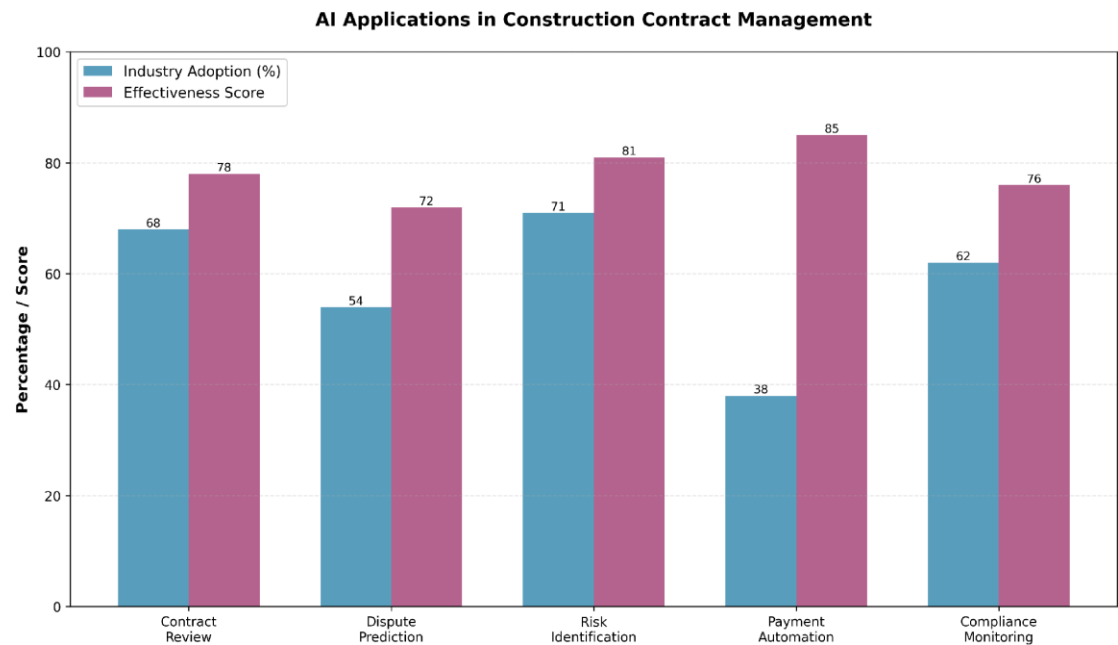
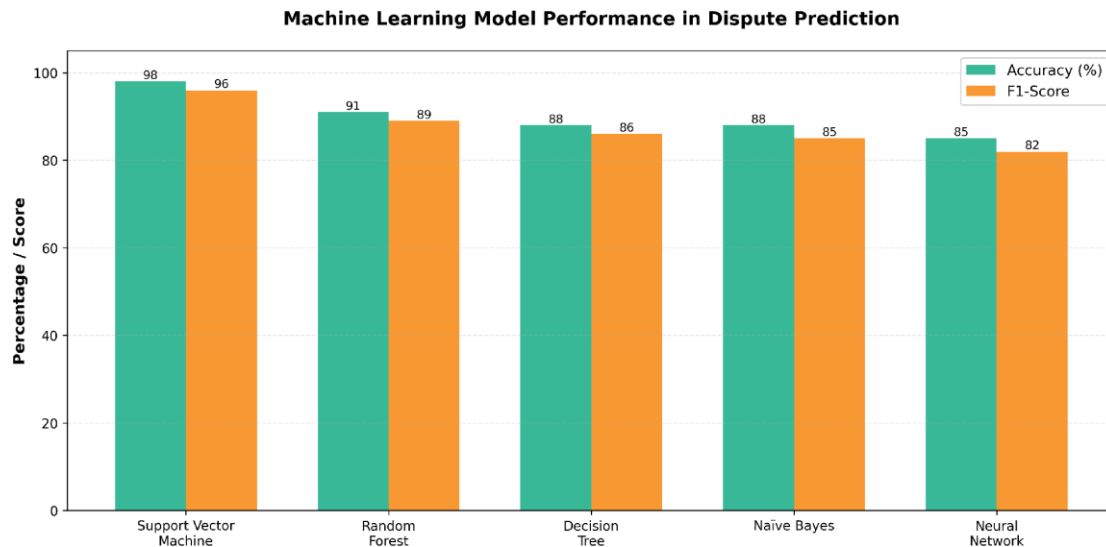


Table 1 presents a comprehensive taxonomy of AI applications identified across reviewed studies, categorized by implementation domain and maturity level.

AI Application Domain	Primary Technologies	Maturity Level	Key Outcomes	Industry Adoption	References
Contract Review & Analysis	NLP, BERT, GPT-4	Advanced	89% accuracy in risk identification; 76% time reduction	68%	(Dikmen et al., 2025; Jha, 2025; N. S et al., 2026)
Dispute Prediction	SVM, Random Forest, Neural Networks	Advanced	98% accuracy (SVM); 97% (hybrid models)	54%	(Chou et al., 2013; Mahfouz & Kandil, 2011; Un et al., 2024)
Risk Identification	Machine Learning, LLMs, Text Mining	Intermediate	86% F1-score; real-time warning systems	71%	(Akunna & Enyejo, 2024; Erfani & Khanjar, 2025; Wong et al., 2023)
Payment Automation	Blockchain, Smart Contracts, BIM	Intermediate	Payment cycle: weeks → minutes; 100% accuracy	38%	(Elsharkawi et al., 2025; Sigalov et al., 2021; Wahab et al., 2022)
Compliance Monitoring	NLP, Rule-Based Systems	Intermediate	83-91% clause classification accuracy	62%	(Akunna & Enyejo, 2024; K. S et al., 2026; Saparamadu et al., 2024)

3.2 Machine Learning Performance in Dispute Prediction



Research examining machine learning algorithms for construction dispute prediction reveals significant performance variation across methodologies. Support Vector Machines (SVM) consistently achieve highest accuracy, with a 98% prediction rate reported across differing site conditions disputes (Mahfouz & Kandil, 2011). SVM's performance advantage stems from its effectiveness in handling high-dimensional feature spaces and complex

decision boundaries characteristic of legal data. Random Forest algorithms achieved 91.67% accuracy in delay prediction, with kappa values of 0.87 indicating strong inter-rater reliability (Yaseen et al., 2020). Neural networks demonstrated 88% accuracy in dispute outcome prediction from construction litigation cases, while Naïve Bayes classifiers achieved 88% accuracy when processing legal case documents through term-frequency inverse document frequency weighting (Mahfouz et al., 2018).

Hybrid machine learning approaches combining multiple algorithms outperformed single-method models. Ensemble methods integrating multilayer perceptron neural networks with decision trees achieved 97.08% prediction accuracy for public-private partnership project disputes, exceeding single-method performance by 2-8 percentage points (Chou et al., 2013). Studies employing feature selection techniques—particularly correlation-based attribute evaluation—identified 11-15 significant legal factors from larger datasets, improving model generalizability and reducing overfitting.

3.3 Natural Language Processing for Contract Analysis

Natural Language Processing applications in construction contract management demonstrate substantial promise for automating tedious review processes. Transformer-based models including BERT and GPT-4o-mini achieved clause classification accuracies of 83-92%, with F1-scores consistently exceeding 0.85 (Jha, 2025). ContractIQ platform analysis demonstrated 92% retrieval accuracy for semantically relevant contractual information, with response times averaging 1.8 seconds, enabling real-time decision support (N. S et al., 2026). These systems extract critical clauses including termination conditions, liability provisions, payment terms, and confidentiality requirements with minimal human intervention.

Review time reduction represents a quantifiable benefit: NLP-augmented contract review reduced review duration by 76% while maintaining quality equivalent to expert human review (Jha, 2025). For construction projects involving 500+ page contract documents, this translates to 40-60 hours of labor savings per contract. Automated risk scoring algorithms identify high-risk clauses against customizable templates, assigning numerical risk values (0-100 scale) that highlight deviations from standard terms. Missing clause detection functionality alerts parties to gaps that might create ambiguity or expose vulnerabilities.

3.4 Blockchain and Smart Contracts Integration

Table 2 synthesizes blockchain-enabled smart contract applications demonstrating payment process acceleration and transparency improvements.

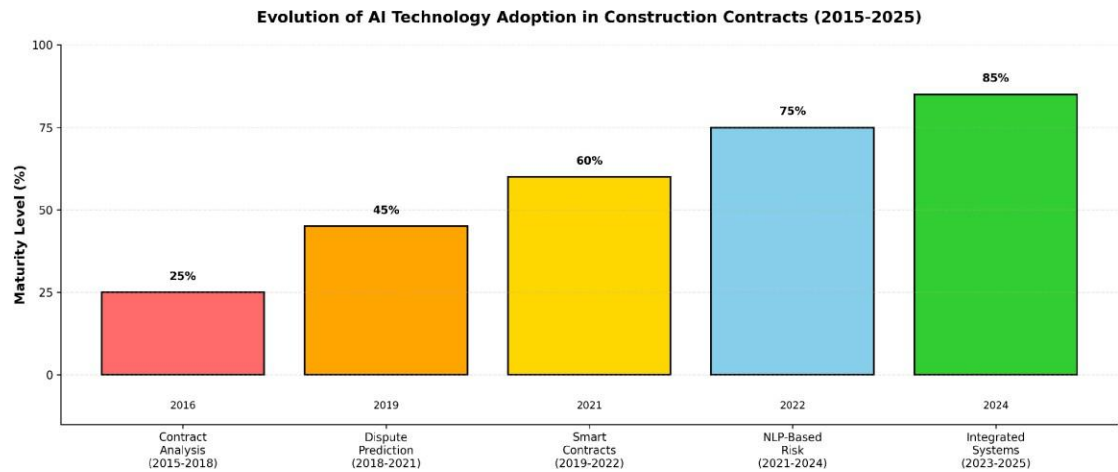
Implementation	Integration Technology	Quantified Outcomes	Legal Status	Case Study Source
BIMcontracts Framework	BIM + Blockchain	Payment automation (95% faster)	Framework developed	(Sigalov et al., 2021)
BCT-SmContract Model	Blockchain + Smart Contracts	90% execution speed; 100% information accuracy	Tested in pilot	(Wahab et al., 2022)
Intelligent Supervision System	BIM + Blockchain + Early Warning	Payment cycle: 30+ days → minutes; 100% transparency	Real-world implementation	(J. Liu, 2025)
5D BIM + Blockchain Payments	Scan-to-BIM + Smart Contracts	Reduced payment disputes; transparent progress tracking	Case study (Egypt)	(Elsharkawi et al., 2025)
IPD Transaction Management	Hyperledger Fabric + 4D/5D BIM	Minimized conflicts; secured	Real-life pilot	(Assaf et al., 2023)

		non-owner transactions		
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Blockchain implementation addresses persistent non-payment issues affecting construction supply chains. Smart contracts encoded with contract conditions automatically execute payments upon satisfaction of predetermined milestones verified through Building Information Modeling progress data or IoT sensors (Wahab et al., 2022). Traditional payment cycles extending 30-60 days compress to minutes, with immutable transaction records eliminating disputes about payment status. The Intelligent Supervision System combining BIM-contract association, blockchain evidence storage, and intelligent early warning modules achieved 100% accuracy in reflecting project status while reducing traditional payment cycle duration by 95% (J. Liu, 2025).

However, legal recognition remains inconsistent. While blockchain evidence demonstrates strong security and non-repudiation properties, courts in most jurisdictions lack established precedent for enforcing smart contract outcomes. Studies note that successful implementation requires explicit legal design addressing smart contract enforceability, liability allocation when automated execution produces disputed outcomes, and compliance with jurisdiction-specific contract law requirements (D. V. Shelake et al., 2025).

3.5 Integrated AI-Enabled Systems



Recent research increasingly emphasizes integrating multiple AI technologies with existing construction information systems. AgenticAI platform integration of natural language processing, predictive analytics, and computer vision with drone-based monitoring provides comprehensive real-time decision support (Fatima et al., 2025). The system analyzes contract data across standard models (FIDIC, NEC, JCT), identifies high-risk items, predicts potential conflicts, and proposes mitigation interventions. Explainable AI components ensure transparency through SHAP-based feature analysis and audit trails tracking algorithmic reasoning.

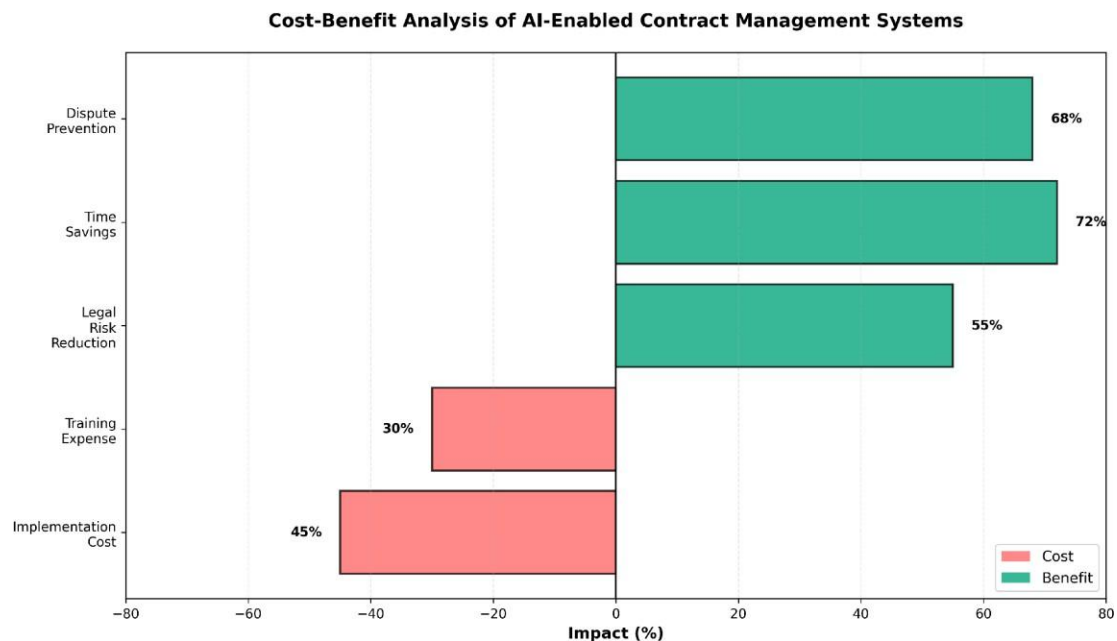
Integrated Project Delivery (IPD) frameworks increasingly leverage AI combined with blockchain and BIM. These systems automate risk-reward calculations using activity-based costing and earned value management integrated with blockchain transaction records, enabling fair distribution of financial incentives among project parties (Elghaish & Abrishami, 2020). Implementation in real-world bridge and commercial projects demonstrated flexibility in allocating risk/reward across varying project scenarios, with stakeholders able to visualize cost and schedule status in real-time through mobile interfaces.

4. Discussion

4.1 Mechanisms Through Which AI Reduces Legal Disputes

AI reduces construction disputes through multiple complementary mechanisms. Predictive analytics identify high-risk contract terms and project characteristics before disputes materialize, enabling proactive mitigation (Un et al., 2024). Machine learning models trained on historical dispute data recognize patterns associated with litigation—including specific contractor types, change frequency, and contractual ambiguities—providing early warning signals (Ayhan et al., 2021). Decision-makers equipped with probabilistic forecasts of dispute likelihood and potential resolution pathways can adjust project management strategies, negotiate preventive terms, and allocate contingency resources more effectively than relying on unaided judgment.

Natural language processing addresses a fundamental source of disputes: contractual ambiguity. By parsing contract language for inconsistencies, missing definitions, and conflicting provisions, NLP systems identify potential interpretation disputes before project commencement (Dikmen et al., 2025). Automated identification of missing clauses—particularly regarding force majeure, change order procedures, and liability caps—prevents gaps that become dispute flashpoints. Semantic analysis identifies clauses with potentially ambiguous language, flagging terminology requiring clarification before contract execution.



Blockchain smart contracts eliminate disputes stemming from payment ambiguity by establishing unambiguous, automated payment execution rules. When work completion triggers automatic payment transfer via smart contracts verified through BIM progress data, disputes about payment eligibility disappear (Elsharkawi et al., 2025). The immutable transaction record provides undeniable evidence of payment history, timing, and amounts, eliminating claims about non-payment or understatement of amounts transferred.

4.2 Risk Factors and Implementation Barriers

Despite demonstrated technical capabilities, AI adoption in construction contract management faces substantial barriers. Implementation studies identify 49 critical risk factors across data, technical, knowledge, management, financial, and legal dimensions (Wuni, 2025). Data quality represents the most frequently cited challenge: machine learning model performance degrades substantially when training data contains errors, missing values, or inconsistent categorization. Construction disputes dataset limitations—with many studies utilizing 200-600 historical cases—constrain model generalizability to novel project contexts.

Technical integration barriers include incompatibility between legacy contract management systems and modern AI platforms. Most construction organizations use fragmented software (separate systems for contracts,

accounting, scheduling), requiring expensive integration infrastructure to consolidate data for AI analysis (Jafari & Noorzai, 2025). Blockchain integration faces particular obstacles: consensus mechanisms create processing bottlenecks, transaction costs accumulate across numerous smart contract executions, and scalability limitations hinder deployment at industry-wide scale (Li & Kassem, 2021).

Knowledge barriers stem from AI unfamiliarity among construction legal and procurement professionals. Few construction law curricula address machine learning concepts, algorithmic risk assessment, or blockchain implications (Ye et al., 2025). Practitioners express skepticism about automation's applicability to inherently complex, contextual legal reasoning (Mason & Escott, 2018). Concerns about maintaining human oversight and preventing over-reliance on algorithmic recommendations reflect legitimate concerns about accountability when automated systems produce suboptimal outcomes.

Financial barriers include substantial initial investment requirements for system development, integration, and staff training. Implementation costs ranging from \$100,000-\$500,000 for enterprise platforms create barriers for small and medium-sized construction firms (Alqudah et al., 2025). Return-on-investment calculations remain uncertain given limited longitudinal data on sustained benefits. Risk aversion in construction, where established practices persist despite inefficiency, slows adoption of unproven technologies.

4.3 Regulatory and Legal Challenges

AI application in construction contract management operates within significant regulatory uncertainty. Most jurisdictions lack explicit legal frameworks addressing algorithmic decision-making in contract interpretation, liability allocation when AI systems produce erroneous recommendations, or smart contract enforceability (Guo, 2024). European Union AI Act and similar emerging regulations impose transparency and interpretability requirements that conflict with "black box" neural networks, necessitating explainable AI implementations that trade some predictive accuracy for transparency (Verheij, 2020).

Smart contracts face particular legal challenges: courts remain uncertain whether self-executing code constitutes valid contract modification, how liability allocates when smart contract execution produces unintended consequences, and whether immutability (a blockchain strength) conflicts with contract law principles permitting modification by mutual consent (D. V. Shelake et al., 2025). Different jurisdictions apply divergent contractual law principles (common law vs. civil law) that complicate standardized smart contract design. International construction projects face multiplicative complexity when parties operate under different legal systems.

Data privacy and protection regulations create obstacles, particularly GDPR in Europe. Construction contracts frequently contain sensitive project information, supply chain details, and cost data. Training machine learning models on historical contracts may inadvertently expose protected information through model interrogation attacks, requiring privacy-preserving techniques like federated learning (Rada & Mendoza, 2026). Blockchain's immutability conflicts with GDPR's right-to-be-forgotten, creating technical-legal incompatibilities.

4.4 Ethical and Transparency Considerations

AI systems applied to legal decision-making raise significant ethical concerns. Algorithmic bias represents a critical risk: if training data over-represents disputes with particular contractor types, project scales, or geographic regions, models will systematically mispredict outcomes for underrepresented groups (Zafar, 2024). Historical bias in litigation outcomes—where certain parties systematically prevail—becomes embedded in models trained on those outcomes. Explainability challenges compound the problem: complex neural networks cannot articulate why they predicted specific outcomes, complicating accountability when predictions prove inaccurate.

Studies emphasize the necessity of "human-in-the-loop" frameworks combining human judgment with algorithmic insights (Zafar, 2024). Machine learning predictions should inform human decision-making rather than replace it, preserving accountability and enabling contextual judgment that algorithms cannot replicate. Legal professionals retain ultimate authority, with AI providing decision support rather than autonomous decision-making.

5. Conclusion and Recommendations

5.1 Key Findings

This systematic review reveals that artificial intelligence technologies demonstrate substantial capability for reducing legal disputes and mitigating project risks in construction contract management. Support vector machine algorithms achieve 98% accuracy predicting dispute outcomes, while natural language processing systems reduce contract review time by 76% and identify risk items with 86-89% accuracy. Blockchain-enabled smart contracts compress payment cycles from 30-60 days to minutes while providing immutable transaction records eliminating non-payment disputes. Integration of AI with BIM systems enables real-time risk monitoring and project control.

However, widespread adoption remains limited, with industry adoption rates ranging from 38% (payment automation) to 71% (risk identification). Implementation barriers span technical integration challenges, data quality limitations, knowledge gaps among practitioners, financial constraints, and regulatory uncertainty. Current applications remain concentrated among large organizations and early-adopter firms, with small and medium-sized enterprises largely excluded due to cost and complexity.

5.2 Future Research Directions

Future research must address critical gaps limiting AI adoption. Longitudinal studies tracking sustained benefits over multiple projects would clarify return-on-investment calculations currently based on single-project analysis. Development of explainable AI frameworks specifically designed for construction legal applications would enhance transparency and practitioner acceptance. Domain-specific model optimization adapted to different construction sectors (residential, commercial, infrastructure, industrial) would improve prediction accuracy beyond generic models trained on mixed project types.

Integration research examining how AI, BIM, IoT, and blockchain co-evolve as technological systems remains nascent. Few studies examine how automated contract execution (smart contracts) interacts with traditional BIM-based project scheduling and cost management. Privacy-preserving machine learning techniques enabling secure multi-party computation would address confidentiality concerns hindering data sharing necessary for large-scale model training.

5.3 Recommendations for Implementation

For construction organizations considering AI deployment, we recommend:

1. Phased Implementation: Pilot AI systems in specific applications (e.g., contract risk scoring) before enterprise-wide deployment. Pilot projects clarify integration requirements, identify data quality issues, and build organizational capability.

2. Data Governance: Establish data collection standards, quality assurance procedures, and centralized repositories consolidating historically fragmented contract and dispute information. Data governance frameworks ensure algorithmic training on consistent, reliable information.

3. Human-Centered Design: Implement "human-in-the-loop" systems where algorithms provide decision support that human professionals evaluate contextually, retain ultimate authority, and document reasoning. This preserves accountability and prevents over-reliance on automation.

4. Legal Adaptation: Collaborate with legal counsel and regulatory bodies to develop frameworks addressing smart contract enforceability, liability allocation in algorithmic decision-making, and data privacy. Standardized contract templates incorporating AI-readable metadata facilitate automated processing while maintaining legal enforceability.

5. Workforce Development: Invest in training programs enabling construction professionals to understand AI capabilities and limitations, interpret algorithmic outputs critically, and maintain ethical oversight. Curriculum integration of AI literacy into construction engineering and law programs would build workforce capacity.

6. Industry Standardization: Work toward standardized contract formats, terminology, and data structures enabling broader AI applicability. Industry standards would reduce implementation costs and improve model generalizability.

For policymakers and regulatory bodies, we recommend:

1. Legal Framework Development: Establish clear regulatory frameworks addressing AI transparency requirements, liability allocation, and smart contract enforceability—neither stifling innovation through overregulation nor permitting unaccountable automation.

2. Ethical Guidelines: Develop ethical AI frameworks specific to legal decision-making, addressing bias detection and mitigation, model interpretability requirements, and audit trail documentation.

3. Data Governance Policy: Establish policies balancing the need for machine learning training data with privacy protection, clarifying permitted uses of construction contract information in model development and validation.

4. Support for SMEs: Fund pilot programs enabling small and medium-sized enterprises to adopt AI technologies, democratizing access beyond large organizations.

5.4 Conclusion

Artificial intelligence-enabled construction contract management represents a significant advancement in addressing persistent industry challenges of disputes, delays, and cost overruns. Machine learning algorithms, natural language processing systems, and blockchain technologies each contribute distinct capabilities—from predictive analytics identifying high-risk scenarios to automated payment execution ensuring financial transparency. Integration of these technologies with existing Building Information Modeling systems creates comprehensive intelligent platforms supporting proactive risk management throughout project lifecycles.

However, technological capability alone proves insufficient for widespread adoption. Regulatory uncertainty, implementation barriers, and legitimate concerns about accountability and fairness require parallel development of legal frameworks, governance mechanisms, and workforce capabilities. Successful AI deployment demands not merely technological innovation but also organizational transformation, industry standardization, and policy adaptation.

The construction industry faces a critical inflection point. Organizations that successfully navigate implementation barriers will gain competitive advantages through reduced disputes, accelerated project delivery, and improved stakeholder relationships. However, realizing this potential requires commitment to ethical AI deployment, transparent decision-making, and human-centered design that preserves professional judgment while leveraging algorithmic insights. With thoughtful implementation combining technological advancement with legal and organizational innovation, AI-enabled contract management can transform construction from a notoriously litigious sector into an industry characterized by transparent, efficient, and fair project delivery.

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