

AMBIGUITY IN BILL OF QUANTITIES DESCRIPTIONS AND PREVENTION STRATEGIES FOR COST DISPUTES BASED ON CASE ANALYSIS

ZhiWei Wang

Hebei Donghan Construction Engineering Co., Ltd, Shijiazhuang 050000, Hebei, China.

Corresponding Email: 393507819@qq.com

Abstract: Ambiguity in bill of quantities (BOQ) descriptions triggers 34.2% of construction contract disputes, resulting in cost overruns of 15%-25% with dispute resolution averaging 11.8 months. Cluster analysis of 128 cases reveals four core ambiguity types: item specification ambiguity (38.6%), scope boundary disputes (29.3%), measurement rule violations (21.1%), and provisional price failure (11.0%). Underlying causes stem from technical specification gaps (missing design details in 26% of projects), human resource deficiencies (absence of dual-signature review systems in 34% of projects), and management failures where compressed bidding cycles (60% of standard duration) and 7.2-day change order delays cause version control breakdowns.

The proposed prevention framework integrates three operational phases: during compilation, BIM parametric modeling eliminates manual transcription errors through automated specification generation; at tendering stage, notarized site investigation meetings establish binding scope definitions while optimized price adjustment formulas address market volatility; finally, BIM-AI fusion enables real-time response to design changes within ≤ 0.8 seconds. Pilot implementations demonstrate 61.3% reduction in dispute incidence.

Keywords: BOQ ambiguity; Cost disputes; Specification ambiguity; BIM-AI integration; Prevention framework

1 INTRODUCTION

The Bill of Quantities (BOQ), as a core document for construction cost management, requires precise descriptions to ensure bid fairness, contract execution efficiency, and project settlement accuracy [1]. In current practice, BOQ ambiguities trigger >30% of contractual disputes industry-wide, prolonging resolution by >10 months on average and inflating costs by 15%–25%. These systemic failures primarily stem from three areas:

1.1 Ambiguities in Work Item Descriptions

Deficiencies in compilers' expertise or diligence frequently cause discrepancies between specifications and design drawings. For instance, failing to specify edge treatment techniques for steel cladding panels sparks audit-contractor valuation conflicts. Similarly, curtain wall lists often confuse measurement rules for face-sealed versus structurally glazed systems. Deeper issues include insufficient drawing detail, non-standardized feature descriptions, and deviations from national valuation standards (e.g., erroneous coding units) [2].

1.2 Unclear Work Scope Boundaries

Vaguely defined responsibilities in tender BOQs generate liability disputes. Typical examples include piping installations where fitting costs for steel versus stainless-steel pipes lack explicit inclusion rules, or firestop interfaces for ductwork causing technical specification conflicts. These problems arise from misalignment between BOQs, tender documents, and technical requirements, misleading bidders on scope boundaries and fueling post-contract claims [3].

1.3 Measurement Rule Conflicts

Contradictions between quantification rules and contract clauses cause settlement breakdowns [4]. Cases reveal imbalances when actual quantities diverge $\geq \pm 15\%$ from BOQ volumes, or when measurement methods contradict national standards. Critical omissions—such as undefined price adjustment mechanisms for material fluctuations or liability allocation for delays—paralyze resolution when changes occur.

These failures originate from institutional-execution gaps: Employers neglect BOQ quality control, violating Article 4.1.2 (mandating employer liability for accuracy) of China's Standard for Bill of Quantities Valuation (GB50500-2013) [5]. Simultaneously, compilers' insufficient field expertise and inadequate design documentation compound descriptive inaccuracies.

This study employs multi-case analysis to deconstruct ambiguity mechanisms, clarify interactions between human error, design flaws, and descriptive deficiencies, and develop phase-based controls covering tender, contracting, and execution. Through dispute mediation principles—such as analyzing tender control prices to determine authentic intent—it establishes integrated safeguards. The research further demonstrates the synergistic value of standardized BIM models and AI-assisted audits, proposing a pipeline solution for cost management refinement.

2 AMBIGUITY TYPES AND CAUSES IN BOQ DESCRIPTIONS

2.1 Typology of BOQ Ambiguities

Cluster analysis of 128 engineering contract dispute cases from China Judgments Online (2015–2019), calibrated via the Supreme People's Court White Paper on Construction Contract Disputes (p. 31), reveals four primary ambiguity types:

2.1.1 Feature description ambiguities (38.6%)

Critical omissions in technical specifications include: granite thickness noted as "25mm" without tolerance ranges ($\pm 2\text{mm}$), or concrete parameters omitting aggregate gradation requirements, triggering quality acceptance disputes. For example, an industrial plant project described arch roofing as "folded-line trusses" without distinguishing factory-precast vs. in-situ casting, causing a ¥1.72 million valuation conflict. Root causes include compilers' overreliance on standard references while ignoring construction variances and inadequate design detailing (e.g., missing prefabricated component connections).

2.1.2 Work boundary disputes (29.3%)

Unclear activity scopes provoke liability conflicts, such as whether dewatering measures are included in excavation support or "substrate preparation" covers existing finishes removal. In ventilation system cases, ambiguous itemization of firestopping led to contractor-auditor disagreements over standard application. Economically, undefined boundaries cause duplicate billing—e.g., disputes on whether fitting installation costs for stainless-steel vs. carbon-steel pipes reside within composite unit prices.

2.1.3 Nonstandard measurement rules (21.1%)

Conflicting units and rules include steelwork priced per "ton" and "square meter" without conversion standards, or earthwork lacking bank volume-to-compacted volume coefficients (one project incurred 217-ton quantity deviations due to missing ratios). Regulatory gaps emerge where national standards like GB50500-2013 inadequately cover new methods—e.g., duplicated item codes for rebar cage fabrication and masonry tie-ins.

2.1.4 Provisional pricing failures (11.0%)

Flawed pricing mechanisms include provisional material costs deviating $>\pm 30\%$ from market rates without adjustment clauses [6]. One project's cable provisional price (¥500/m) caused supply chain collapse when market prices surged to ¥800/m, as the contract omitted risk-sharing protocols.

Risk propagation occurs when employers disregard market trends, disconnecting BOQ control prices from actual conditions and heightening execution risks. See Table 1 for summary.

Table 1 Analysis of Ambiguity Types in Bill of Quantities Descriptions

Ambiguity Type	Proportion	Representative Cases	Primary Impact
Specification Ambiguity	38.6%	<ul style="list-style-type: none"> Granite thickness specified as "25mm" without tolerance ranges ($\pm 1\text{mm}$) Concrete parameters omitting aggregate gradation requirements 	Quality acceptance disputes
Scope Boundary Disputes	29.3%	<ul style="list-style-type: none"> Unclear inclusion of dewatering measures in foundation pit support Ambiguous coverage of existing finish removal under "base layer treatment" in renovation works 	Responsibility conflicts & duplicate billing
Measurement Rule Violations	21.1%	<ul style="list-style-type: none"> Dual pricing ("ton" vs. "m²") without conversion standards in steel structures Missing coefficients for loose-to-compacted volume conversion in earthworks 	217-ton quantity deviation (factory project)
Provisional Price Failure	11.0%	<ul style="list-style-type: none"> Provisional cable price (500 CNY/m) surging to 800 CNY/m (60% deviation) without adjustment mechanism 	Supply chain disruptions

2.2 Deep-Seated Contradictions Underlying Ambiguity

2.2.1 Technical dimension: design-specification misalignment

Technically, insufficient detail in design drawings critically compromises BOQ development [7]. Statistics show 26% of projects suffer from internal contradictions within drawings (e.g., conflicts between general notes and detail callouts or architectural versus structural plans), forcing compilers to rely on fragmented data. Concurrently, China's Standard for Bill of Quantities Valuation (GB50500-2013) exhibits definitional flaws: ambiguities in terms like provisional

works and incidental items stem from lacking standardized descriptive frameworks, generating substantial settlement disputes and impeding cost valuation.

2.2.2 Human dimension: competency and process gaps

Human factors manifest in skill deficits and procedural lapses. In 34% of projects, inadequate enforcement of cross-verification protocols (compiler-reviewer dual-signoff) fails to intercept fundamental errors [8]. For example, omitting specifications for rebar coupler types (mechanical vs. welded) triggers construction method cost disputes. Additionally, compilers' uneven expertise—some lacking field experience—leads to neglected details like edge treatment techniques; others mechanically apply cost norms without referencing construction codes, causing severe deviations between described item features and actual requirements.

2.2.3 Managerial dimension: process coordination failures

Managerially, fragmented coordination is prevalent. Unrealistic tender schedule compression—some reduced to 60% of standard cycles—forces compilers to complete BOQs within 72 hours, raising omission rates by 15%. Design change management shows critical delays: modifications took 7.2 days on average to propagate to cost teams. In one project, only 9 out of 37 changes updated the BOQ, paralyzing coordination mechanisms. Contractual ambiguities compound risks: employers frequently violate mandatory Article 4.1.2 (stating employer liability for BOQ accuracy), transferring risk to contractors [9]. Conversely, contractors forfeit adjustment rights by failing to timely claim changes, undermining cost control and stakeholder interests.

3 EMPIRICAL ANALYSIS OF COST DISPUTES TRIGGERED BY AMBIGUITY

3.1 Cost and Schedule Risks from Ambiguous Item Descriptions

Ambiguous feature descriptions in tender BOQs are primary triggers for cost disputes. Representative cases include:

3.1.1 Stone curtain wall thickness dispute ((2018) Jing 04 Min Zhong No. 3721)

The tender BOQ omitted stone thickness specifications. The contractor used 15mm stone (¥480/m²), while the employer required 25mm (¥720/m²). Third-party tests showed the 15mm stone exceeded wind-load deformation limits by 23%, causing ¥2.78 million rework costs and 5-month delays. The court invoked Article 4.1.2 (mandatory provision) of GB50500-2013, ruling the employer liable for omitting safety-critical parameters [10].

3.1.2 Unclear arch roofing process

A BOQ vaguely described arch roofing as "folded-line trusses" without specifying factory-precast versus in-situ casting. Post-construction method changes incurred ¥1.72 million extra costs. The court held that bidder silence didn't absolve the employer of liability given material tender defects.

3.1.3 Steel panel edge treatment conflict

Unspecified edge treatments led auditors to deduct costs by treating them as separate items, while the contractor claimed commercial concessions—highlighting liability misalignment from ambiguous descriptions.

Root causes:

Technical: Inadequate design drawing details (e.g., conflicts between general notes and details, architectural-structural plan inconsistencies) force compilers to use incomplete data.

Accountability: Violation of GB50500-2013 Article 4.1.2 shifts employer liability to contractors.

Evidence: Contractor-submitted Request for Clarification and supervisor inspection records formed irrefutable evidence chains proving employer fault.

3.2 Cost Compensation Disputes from Omitted Items

Omissions frequently cause settlement deadlocks:

3.2.1 Missing cable firestop item

Design documents specified firestopping (market rate: ¥85/unit), but the BOQ omitted it. Arbitration awarded the contractor a 15% premium over similar item rates (¥1.21 million compensation), per GB50500-2013 Article 9.4 (pricing new items).

3.2.2 Conflicting fireproofing coating code

A BOQ specified "thin-film fireproofing" under item code 010605001002 (profiled steel decking)—which inherently excludes coatings. Disputes arose over whether to deduct costs for unexecuted work, exposing systemic code-description misalignment.

Liability and Compensation Logic:

(1) Unit-price contracts permit adjustment for omissions; lump-sum contracts require explicit risk allocation clauses.

(2) Employers bear liability if unclear designs coincide with vague BOQs; contractors assume risk for unqueried ambiguities in detailed BOQs.

(3) Omissions stem from compilers' skill gaps: 26% of cases involve critical process omissions due to designers copying drawings without interpreting implied requirements.

3.3 Cost Quantification and Industry Trends

Judicial data quantifies BOQ ambiguity impacts:

3.3.1 Direct economic costs

Dispute resolution fees (litigation, forensics, counsel) and delay penalties average 28.5% of contested amounts. One factory project incurred >¥3 million extra costs from 217-ton quantity deviations.

3.3.2 Judicial tendencies

Courts favor contractors in 63% of ambiguity cases, strictly enforcing employer accountability — especially for breaching GB50500-2013 due diligence obligations.

3.3.3 Managerial efficacy

Empirical data shows a 10% increase in BOQ precision reduces disputes by 18.7% ($p < 0.05$). Zhejiang Province's Tender Control Price Analysis mechanism raised dispute resolution success by 32%.

Systemic Failures:

- (1) Weak intermediary expertise: 34% of projects lack cross-verification protocols, allowing basic errors.
- (2) Tender periods compressed to 60% of standard duration: one project's 72-hour BOQ preparation raised omissions by 15%.
- (3) Design change propagation delays (avg. 7.2 days): only 9 of 37 changes updated a project's BOQ.

3.4 Systemic Root Causes of Disputes

Core conflicts lie in two dimensions:

3.4.1 Structural deficiencies in BOQ preparation

Skill gaps: Compilers mechanically apply cost norms while ignoring construction variances (e.g., failing to differentiate installation costs for carbon-steel vs. stainless-steel pipe fittings) [11].

Professional negligence: Overlooking inevitable costs (e.g., omitting dewatering measures in excavation BOQs).

Regulatory noncompliance: Ambiguous GB50500-2013 definitions (e.g., provisional works) cause measurement conflicts, as with the dual "ton"/"m²" pricing in steelwork lacking conversion standards.

3.4.2 Contract mechanism-legal efficacy conflicts

- (1) Imbalanced risk allocation: "All-risk" clauses in lump-sum contracts contradict statutory employer liability for BOQ accuracy, risking invalidity under mandatory provisions.
- (2) Statutory claim traps: Contractors waive adjustment rights if failing to submit claims within 14 calendar days, as in a prefabricated toilet project where ambiguous descriptions caused loss.
- (3) Ineffective mediation: Non-binding guidelines (e.g., Chengdu's " $\pm 15\%$ quantity deviation adjustment") cannot resolve unbalanced bid risks.

4 PREVENTION FRAMEWORK FOR BOQ AMBIGUITY

4.1 Standardization in Compilation Phase

Parametric BIM components (e.g., Revit family attributes) automate preliminary descriptions, ensuring full transmission of 23 critical parameters like concrete durability grade while eliminating manual transcription errors. An enterprise structured feature database mandates $\geq 90\%$ template adoption rate for new projects—explicitly defining granite wall thickness as " 25 ± 0.5 mm" (versus original "25 mm") and fire-rated cable sealing with " ≥ 2 h" endurance (versus ambiguous " ≥ 2 hours") [12]. Cost practitioners undergo "BOQ Compilation Competency Certification"; those with $>5\%$ error rates face license suspension. OA systems formalize tri-party sign-offs (design/cost/construction), automatically triggering alerts after 48-hour response delays.

4.2 Hierarchical Prevention in Tendering & Contracting

Legally binding notarized site investigation clarifies technical ambiguities, with meeting minutes annexed to contracts [13]. Special conditions define conflict resolution: "Where BOQ conflicts with drawings, the stricter technical requirement prevails." Optimized price adjustment formulas activate when quantity deviations exceed $\pm 10\%$ and steel price fluctuations surpass $\pm 5\%$:

Final Price = Bid Price \times (Actual Quantity / Tendered Quantity) \times (Current Steel Index / Base Index).

4.3 BIM-AI Integration for Technical Enablement

An NLP-based review system operates via: Text input \rightarrow Semantic segmentation \rightarrow Ambiguity detection \rightarrow Standard library comparison \rightarrow Revision suggestions. Implementation in Shenzhen hospital projects reduced ambiguous clauses by 41%. A BIM quantity-dynamic linkage engine enables: Revit property binding \rightarrow Real-time recalculation upon design changes \rightarrow QS comparison reports. Validation in Shenzhen intercity rail projects showed ≤ 0.8 -second responses with $<0.5\%$ error rates. VR simulations visualize work interfaces, achieving 100% contractor boundary comprehension.

5 CONCLUSIONS AND RECOMMENDATIONS

BOQ ambiguity fundamentally stems from technical standard gaps and management disconnects [14]. China's Guidelines for Construction Cost Data Standards confirms: Standardized feature databases reduce ambiguous descriptions from 26.5% to 14.2%; Contract price mechanisms cut dispute claims by 61.3% in pilots; BIM-AI integration compresses design change responses to ≤ 0.8 seconds. Future advancements require:

1. Real-time ambiguity monitoring via deep learning models integrated with enterprise feature libraries;
2. Blockchain-based immutability for BOQ compilation records across drafting/modification/approval stages;
3. State-mandated "National Construction Description Standard Library" (reference: UK Uniclass 2015) requiring validation for all new projects.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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