JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Assessment of Construction Planning, Quality Control and Cost Management Practices in PEB Warehouse Projects: A Case Study

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ABSTRACT

This study assesses the interrelationship of planning, quality-control documentation and cost management in a completed industrial PEB warehouse project in Latur, India. A single-case documentary approach combines tender and work-order records, architectural drawings, the ninth and final running-account bill and the excess-and-saving statement. The original contract period was 8 December 2023 to 8 December 2025; reported completion was 31 October 2026, following an internally approved extension of time associated with a 600 mm plinth-level increase due to external road development. For BOQ Item A-15, the recorded filling quantity rose from 3,142.562 to 6,224.830 m³, an excess of 3,082.268 m³ (98.08%) with a recorded item increase of ₹24,83,636.07. The records support a clear quantity variation but do not establish a complete causal decomposition of the excess or verify quality-test compliance. The paper proposes integrated change-control and inspection-record practices and identifies the documentary evidence required for a stronger explanatory analysis.

Keywords: pre-engineered building; warehouse; construction planning; quality control; quantity surveying; BOQ variation; extension of time; case study.

1. INTRODUCTION

Research context

Industrial warehouse projects contain interdependent design and construction packages. A change in an external level can alter earthwork quantities and access geometry, while also affecting sequencing and the evidence required for payment. This interdependence makes the warehouse a useful setting for examining whether planning, quality and commercial records are managed as a coordinated system.

The paper does not compare all PEB projects or establish an industry average. It analyses one completed project through available documentary records, identifying both what those records establish and what remains uncertain.

Industrial warehouse delivery combines structural steel design and erection with site preparation, foundations, floor construction, services and external infrastructure. PEB projects may benefit from off-site fabrication, but site interfaces remain important determinants of cost and programme outcomes.

Planning, quality control and cost management are often treated as separate workstreams. In practice, a change to building levels can affect quantities, construction sequence, inspection requirements and contractual time administration at the same time.

This paper examines these interfaces through the completed Balbharati warehouse project at Plot No. F-91, MIDC, Latur. The case is selected because tender, work-order and measured-quantity records are available; it is not presented as representative of all PEB warehouses.

2. RESEARCH QUESTIONS AND CONTRIBUTION

Operational definitions

Planning practice is operationalised through baseline dates, reported changes and EOT evidence. Quality-control practice is examined through contractual acceptance requirements and the availability of completed inspection records. Cost management is operationalised through BOQ quantities, statement rates, recorded variations and the distinction between measured and certified amounts.

The study deliberately separates “requirement exists” from “requirement was complied with”. For example, the BOQ requirement for layered compaction establishes the specified method, but cannot substitute for test results. This distinction is central to the validity of the findings.

The principal question is: How do documented construction changes interact with schedule administration, quality-record requirements and BOQ-based cost control in an industrial warehouse project?

Sub-question 1: What can the original contract and actual completion dates establish about time performance, and what cannot be concluded without the approved EOT duration and updated programme?

Sub-question 2: What does the excess-and-saving statement establish about the measured filling quantity and cost? Sub-question 3: What evidence would be necessary to verify compliance with specified filling and steel erection quality requirements?

The contribution is a transparent, evidence-bounded case analysis with a replicable document-extraction matrix. It avoids treating missing inspection records as failed inspections or treating elapsed time as an unapproved contractor delay.

3. RELATED TECHNICAL FRAMEWORK

Conceptual framework

The conceptual model has five linked stages: initiating change, technical review, programme evaluation, quality verification and commercial reconciliation. Each stage creates records that should reference the preceding stage. A gap in one link can weaken the ability to explain later time or cost outcomes.

For planning, the relevant concepts are logic-linked schedules, critical-path effects and contemporaneous records. For quality, they are inspection and test plans, material approvals, hold points and corrective action. For commercial control, they are item definitions, measurement books, rate application and final-account reconciliation. These concepts guide document coding; they are not presented as statistically validated causal relationships.

Construction planning requires a baseline programme, documented revisions, progress measurements and a means of assessing event impacts on critical activities. Without the baseline and approved extension records, a date comparison measures elapsed variance but not contractual liability.

Quality control requires specified criteria, inspection and test plans, records of checks and resolution of nonconformities. A tender specification is evidence of a requirement; a signed test or inspection record is evidence of its execution and result.

Cost management in measured contracts requires alignment of BOQ descriptions, estimated quantities, executed measurements, applicable rates and certified payment records. Quantity variation is not identical to the change in total final account value.

4. CASE DESCRIPTION AND DATA SOURCES

Project boundary and documentary provenance

The case concerns the new godown at Plot F-91, MIDC, Latur for Balbharati. The contract documents identify the contractor as M/s ARM Infrastructure and the consultant as Gopal Shinde. The project record reports a 600 mm plinth increase linked to MIDC road works and an EOT approved through an internal committee.

Documents are treated according to their evidential role. The tender defines intended work and measurement provisions; the work order defines contractual dates and amount; the excess-and-saving statement reports measured quantity changes; and the RA bill is a separate billing record. User-confirmed completion and the description of the oral instruction are reported as project information rather than independently verified certificates.

The project is the New Godown Building at Plot No. F-91, MIDC, Latur, for the Maharashtra State Bureau of Textbook Production and Curriculum Research (Balbharati), Pune. The contractor was M/s ARM Infrastructure; the architect/consultant was Gopal Shinde, Latur.

The original accepted contract value was ₹5,12,00,380, with GST treated separately under the work order. The work order was dated 5 December 2023, with original contract commencement 8 December 2023 and scheduled completion 8 December 2025.

Data sources include tender specifications and BOQ, work order, approved-plan information, ninth and final RA bill and excess-and-saving statement. The 600 mm plinth-level instruction, internal committee EOT approval and actual completion date are reported project information awaiting independent approval-record verification.

Source	Use in analysis
Work order	Contract dates and accepted value
Excess saving statement	Item quantities, rates and amounts
Tender BOQ	Item scope and specified work method
RA bill	Potential payment reconciliation
Reported site information	Context for level revision and EOT

5. METHODOLOGY

Document coding and reproducibility

Each extracted observation is assigned a source, item or clause, unit, original value, revised value, calculation and confidence note. The quantity difference is calculated as Qexecuted minus Qoriginal; the percentage variation is the difference divided by Qoriginal. Amounts are retained as reported in the statement rather than recomputed from rounded display rates when rounding could create a minor discrepancy.

A second pass checks whether similarly named BOQ items refer to different locations. This is necessary because the godown filling item and the RCC-road filling item both describe filling but have different original and executed quantities. The analysis avoids double counting and records unresolved discrepancies rather than adjusting figures to force agreement.

The study uses a retrospective single-case documentary design. Numerical observations are extracted only where an identifiable source supplies the unit, value and description. A source-status field separates written project records from reported site information and from analytical calculations.

The quantity deviation is defined as executed quantity minus estimated BOQ quantity. Percentage deviation equals quantity deviation divided by estimated quantity, multiplied by 100. The original-to-actual completion difference is expressed in calendar days and is not labelled a compensable delay.

The analysis applies three evidence tests: (1) traceability to an identified document, (2) consistency of unit and calculation, and (3) separation of observation from causal explanation. Where quality records or revised programmes are absent, the paper reports a data limitation rather than an outcome.

Measure	Operational definition
Quantity deviation	Executed less estimated quantity
Quantity variation %	Deviation / estimated × 100
Date variance	Actual less originally scheduled date
Quality compliance	Requires inspection/test evidence
Change causation	Requires approved change and level records

6. RESULTS: PLANNING AND TIME

Schedule interpretation

The original scheduled completion was 8 December 2025 and the reported actual completion was 31 October 2026, a calendar difference of 327 days. This difference is not equivalent to contractor-attributable delay. It cannot establish critical-path causation, compensable delay or liquidated damages without the approved EOT duration and contemporaneous programme updates.

The reported committee approval establishes the existence of an EOT decision in project information. However, the committee resolution, effective revised completion date and supporting delay analysis have not been supplied. The defensible result is therefore a schedule variance and a documented evidence gap, not a quantified finding of excusable or inexcusable delay.

The original contract period was 24 months, from 8 December 2023 to 8 December 2025. The actual completion date supplied for the project was 31 October 2026. The elapsed difference from the originally scheduled completion date is 327 calendar days.

Project information states that MIDC road development required an increase of 600 mm in the warehouse plinth level. The architect/consultant communicated the change orally, and an internal committee approved an extension of time.

These facts support the existence of a significant change event and an EOT approval. They do not establish the approved number of extension days, the revised contractual completion date, critical-path impact, concurrent delays or responsibility for every day between the original and actual completion dates.

Date / event	Status
08 Dec 2023	Contract commencement — work order
08 Dec 2025	Original scheduled completion — work order
31 Oct 2026	Actual completion — reported
327 days	Elapsed difference — calculated
EOT duration	Not independently verified

7. RESULTS: QUANTITY AND COST

Commercial interpretation and sensitivity

The A-15 original quantity is 3,142.562 m³; executed quantity is 6,224.830 m³. Subtraction yields 3,082.268 m³, and division by the original yields approximately 98.08%. The statement records an excess amount of ₹24,83,636.07. The amount is item-specific and must not be described as the project's total cost overrun.

A 600 mm rise applied uniformly across a hypothetical footprint would yield an added geometric volume equal to 0.6 multiplied by that footprint in square metres. This relationship is useful as a diagnostic but cannot be used to infer the actual changed footprint or explain the entire measured excess. Road approaches, existing ground levels and measurement rules would need to be checked against drawings and survey records.

The Excess Saving Statement records Godown Item A-15, filling in plinth and floors with approved contractor-supplied material in 15–20 cm layers including watering and compaction. The estimated quantity was 3,142.562 m³ and the executed quantity was 6,224.830 m³.

The measured excess was 6,224.830 − 3,142.562 = 3,082.268 m³. Relative increase = (3,082.268 / 3,142.562) × 100 = 98.08% (rounded). The statement shows an item rate of ₹805.782/m³ and excess amount of ₹24,83,636.07.

The entire excess cannot be assigned exclusively to the 600 mm level change without original and revised level sheets, the actual affected area and a volume reconciliation. The broader final-account figures require reconciliation before inferring a total cost overrun.

BOQ Item A-15	Recorded result
Estimated quantity	3,142.562 m³
Executed quantity	6,224.830 m³
Excess	3,082.268 m³
Relative increase	98.08%
Recorded excess amount	₹24,83,636.07

8. RESULTS: QUALITY-CONTROL EVIDENCE

Quality evidence matrix

The filling BOQ specifies contractor-supplied approved material placed in 15–20 cm layers with watering and compaction. A complete compliance chain would include source approval, layer identification, level checks, test results where specified and engineer acceptance. The available statement confirms quantities and item wording but does not provide this chain.

The same evidence distinction applies to PEB steel: drawings and specifications define requirements, while fabrication certificates, bolt records, weld inspection, alignment checks and coating reports would be needed to assess executed quality. The study cannot report a defect rate or pass percentage from absent records.

The BOQ requires the filling material to be approved and placed in 15–20 cm layers with watering and compaction. These are specified procedural requirements. The present document set does not provide the corresponding layer-wise density results, test certificates or signed acceptance sheets.

Quality outcomes for structural steel, RCC and the roof envelope likewise cannot be quantified without inspection records, material certificates and nonconformance closure documentation. The absence of such records from the research dataset does not prove that inspections were omitted or that workmanship was deficient.

The evidence gap itself has management implications: an integrated quality register should link inspection stage, location, reference drawing, test result, acceptance status and the RA-bill quantity being certified.

Quality domain	Evidence needed
Murrum filling	Layer logs, density/compaction records
RCC	Concrete test and reinforcement records
Steel frame	Fabrication and erection inspections
Roofing	Fixing and leakage inspections

9. DISCUSSION

The case shows how an external infrastructure change can cross technical and commercial boundaries. A revised plinth level may require additional fill and re-sequencing, while the measured contract captures the executed volume under an existing BOQ item.

The recorded filling increase is substantial, but the documentary chain is incomplete for causal allocation. The consultant instruction was oral; the EOT was reportedly approved internally; the present dataset lacks a revised drawing and committee resolution extract. A stronger causal study would triangulate those records with survey levels, daily progress reports and approved variation calculations.

Planning, quality and cost controls should therefore be linked at change-event level. The same change identifier can appear in the technical query, updated programme, inspection plan, measurement book and payment certificate, enabling traceable project decisions.

10. PRACTICAL CONTROL FRAMEWORK

A project change register should capture event date, initiator, technical reason, instruction medium, approved drawing, affected BOQ items, programme effect, quality hold points and decision authority. This is especially useful when changes originate outside the contractor's direct control.

A linked quantity register should compare estimated and executed values by item and work location, record supporting measurements, and flag large variations for rate and authorization review. Payment certificates should be reconciled separately from the quantity statement.

For quality, an inspection matrix should connect each measured activity to its required acceptance evidence. In a PEB warehouse this includes earthwork and compaction, concrete, anchors, structural steel and cladding.

Control	Minimum linked evidence
Change	Instruction and approval reference
Time	Baseline and revised programme
Cost	Measurement and BOQ item
Quality	Inspection/test and acceptance
Closeout	Final bill and completion record

11. LIMITATIONS AND FUTURE RESEARCH

Threats to validity

The primary limitation is incomplete documentary coverage: no signed EOT resolution, baseline and updated critical-path programmes, full inspection/test dossier or independently reconciled final account is available for this analysis. A second limitation is that the case study is retrospective, so the chronology of some decisions depends on reported project information.

Future work should obtain dated instructions, original and revised levels, layer-wise compaction evidence, monthly progress records and certified bill abstracts. A comparative sample of multiple PEB projects could then test whether integrated change-control practices are associated with lower reconciliation time or fewer disputes.

This is a single-case study based on a limited documentary dataset. It does not establish general PEB productivity, a comparative cost advantage, causal critical-path delay or verified material quality outcomes.

Future research should obtain approved revised drawings, pre- and post-change survey levels, EOT committee minutes, updated programmes, test records, final certified account and stakeholder interviews subject to institutional permission.

A multi-project comparison could then assess whether the integrated control framework is associated with fewer unrecorded changes, faster measurement reconciliation or improved inspection closure. Such effects should be measured prospectively rather than assumed.

12. CONCLUSION

Management and research implications

The measured A-15 quantity variation is demonstrable; the exact causal share of the 600 mm plinth change is not. The contractual and reported completion dates establish a schedule difference, but the approved EOT period is not evidenced. These bounded findings show how quantitative commercial records and incomplete planning or quality records can coexist.

For practitioners, the immediate implication is a traceable change register with cross-references to drawings, measurements, inspection evidence and approvals. For researchers, the contribution is a replicable document-analysis method that can be applied to other industrial projects when richer contemporaneous data become available.

The documented Balbharati warehouse case demonstrates a measurable BOQ filling variation alongside a reported plinth-level change and internally approved time extension. Item A-15 increased by 3,082.268 m³ (98.08%), with a recorded additional item amount of ₹24,83,636.07.

The analysis supports a management recommendation for linked change, programme, inspection and billing records. It does not support attributing the entire filling excess to the 600 mm revision, asserting defective quality, or treating the 327-day elapsed date variance as unapproved delay.

The principal research value lies in showing how evidence discipline improves the interpretation of planning and cost data in industrial warehouse construction.

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ANNEXURE — SITE PHOTOGRAPHS

Photographs supplied with the project materials. Captions identify visible features only; photographs do not independently establish compliance with specifications, approved variations, completion certification or test results.



Photograph 1. Earlier construction-stage view of external works and building enclosure.



Photograph 2. Interior view showing roof steelwork and warehouse space during construction.



Photograph 3. External ground and approach works adjacent to the warehouse.



Photograph 4. External paving and drainage-side work zone alongside the building.



Photograph 5. Building entrance elevation and adjoining external works.



Photograph 6. Later-stage interior view showing steel roof structure and warehouse floor.