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INTEGRATED CONSTRUCTION MANAGEMENT: A METHODOLOGY FOR OPERATIONAL EFFICIENCY AND WASTE REDUCTION IN THE UNITED STATES CONSTRUCTION INDUSTRY

Gestão Integrada de Obras: Metodologia
para Eficiência Operacional e Redução
de Desperdícios na Construção
Civil dos Estados Unidos

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ABSTRACT | Fragmentation among planning, procurement, inspection, quality, and monitoring activities may hinder the timely identification of constraints and nonconformities in construction projects. This article proposes an integrated construction management methodology, referred to in this manuscript as the Integrated Planning, Materials, and Quality Model (IPMQM), designed for future application and evaluation in residential and commercial projects in the United States. The research is applied in nature, adopts a qualitative approach, and is technical and proposal-oriented, drawing on a targeted narrative review of the literature on lean production, collaborative planning, quality management, and rework, supplemented by a mapping of the professional competencies reported by the author. The model comprises six operational modules, control documents, decision rules, and performance indicators. As a theoretical outcome, a replicable implementation protocol and a before-and-after evaluation plan are presented, without attributing empirically unverified effectiveness to the proposed model. Future application will require adaptation to the standards, contracts, and licensing requirements applicable to the relevant U.S. state and type of construction project.

Keywords | Construction Management; Lean Construction; Materials Control; Quality Control; Rework; United States.

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RESUMO | A fragmentação entre planejamento, suprimentos, fiscalização, qualidade e monitoramento pode dificultar a identificação tempestiva de restrições e não conformidades em empreendimentos da construção civil. Este artigo propõe uma metodologia de gestão integrada de obras, denominada Modelo Integrado de Planejamento, Materiais e Qualidade (MIPMQ), concebida para futura aplicação e avaliação em projetos residenciais e comerciais nos Estados Unidos. A pesquisa é de natureza aplicada, abordagem qualitativa e caráter técnico-propositivo, fundamentada em revisão narrativa dirigida da literatura sobre produção enxuta, planejamento colaborativo, gestão da qualidade e retrabalho, complementada pelo mapeamento das competências profissionais relatadas pelo autor. O modelo reúne seis módulos operacionais, documentos de controle, regras de decisão e indicadores de desempenho. Como resultado teórico, apresenta-se um protocolo replicável de implantação e um plano de avaliação antes e depois, sem atribuir eficácia empírica ainda não demonstrada. A aplicação futura exigirá adequação às normas, contratos e requisitos de licenciamento pertinentes ao estado e ao tipo de empreendimento norte-americano.

Palavras-chave | Gestão de obras; Construção enxuta; Controle de materiais; Controle de qualidade; Retrabalho.

1. INTRODUCTION

The execution of residential and commercial construction projects involves interdependent flows of design documents, labor, materials, equipment, inspections, and field decisions. When these activities are monitored through isolated control systems, delays in material availability, technical incompatibilities, and nonconformities may only be detected after they have affected the production sequence. The management challenge extends beyond schedule preparation: it requires verifying whether each activity is ready for execution, whether the correct materials are available, whether acceptance criteria are known, and whether deviations are addressed before they propagate.

The production planning literature, exemplified by the Last Planner System, distinguishes the establishment of targets from operational commitments to executable activities (BALLARD, 2000; BALLARD; TOMMELEIN, 2021). Studies on rework also demonstrate the importance of investigating its causes and establishing consistent measurement criteria, thereby avoiding the extrapolation of costs across heterogeneous projects (LOVE; EDWARDS, 2004; LOVE, 2026). Quality management provides a complementary framework based on processes, documentation, performance evaluation, and continuous improvement, as addressed in the current edition of ISO 9001:2026.

The author reports professional experience in Brazil involving construction monitoring, quantity measurements, interpretation of design documents, inspection, materials control, and scheduling. These elements inform the selection of functions covered by the proposal but do not, in themselves, constitute evidence of quantitative results or prior validation of the model. The objective of this study is to formulate an integrated protocol sufficiently explicit to be implemented and tested across different construction projects, considering its future adaptation to the United States context.

The research question is: How can a replicable operational methodology be structured to integrate short-term planning, procurement, quality control, and deviation recording

in order to enable the evaluation of efficiency and rework in residential and commercial construction projects?

2. THEORETICAL BACKGROUND

2.1 Production Planning and Workflow Reliability

Conventional planning defines sequences, milestones, and anticipated resources; however, the fulfillment of these forecasts depends on constraint removal and coordination among teams. Ballard (2000) proposes the Last Planner System as an approach to production control, emphasizing the reliability of commitments. Ballard and Tommelein (2021) further develop the integration of planning and control, highlighting constraint analysis, short-term scheduling, and learning from variations. The present article draws on these principles as its foundation without claiming that the proposed model constitutes a certified or equivalent implementation of the Last Planner System.

2.2 Quality, Traceability, and Decision-Making

ISO 9001:2026 establishes requirements for quality management systems, emphasizing processes, documented information, performance evaluation, and improvement. In the construction industry, the managerial application of these principles requires translating contractual requirements and specifications into verifiable inspection points, defined responsibilities, and retrievable records. Reference to the standard does not imply that the methodology proposed herein ensures compliance or certification; its use depends on a specific assessment and access to the complete standard.

2.3 Rework and Waste

Rework refers to the repetition of an activity that was performed inadequately or in disagreement with established requirements. Love and Edwards (2004) investigated the determinants of rework in building construction projects, demonstrating the importance of examining causes rather than treating occurrences as isolated events. A subsequent study by Love (2026) highlights the challenges involved in measuring rework costs, reinforcing the need to establish definitions, boundaries, and data collection methods in advance. In this study, material waste, delays, and rework will be measured separately to avoid double counting.

3. RESEARCH METHODOLOGY

The research is applied, exploratory, and technical and proposal-oriented. It employs a targeted narrative review of academic and normative sources, an analysis of the professional functions described in the documentation provided by the author, and the synthesis of an

operational protocol suitable for future testing. No interviews, participant observation, case studies in the United States, controlled trials, or statistical analyses of construction project results were conducted. Therefore, the results section describes the methodological product developed rather than demonstrated productivity gains.

The model was developed through four analytical steps: (i) delimitation of management problems and observable variables; (ii) identification of relationships among planning, resource availability, and inspection points; (iii) definition of documents, indicators, and escalation criteria; and (iv) design of a prospective evaluation protocol. The review is narrative and should not be confused with an exhaustive systematic review.

4. PROPOSED RESULTS: INTEGRATED PLANNING, MATERIALS, AND QUALITY MODEL (IPMQM)

The IPMQM is a proposal presented for the author's technical assessment, rather than a methodology whose prior authorship, historical application, or effectiveness has already been documented and verified. Its unit of application is a construction project with an identified scope, baseline schedule, responsible personnel, materials list, and acceptance requirements.

Module 1 – Diagnosis and Baseline

Consolidate the project scope, current design documents and revisions, work breakdown structure, baseline schedule, reference budget, critical materials list, and responsibility matrix. Record outstanding issues and assumptions before mobilization.

Module 2 – Medium- and Short-Term Planning

Conduct periodic meetings to prepare work fronts. For each activity, verify approved design documents, workforce, equipment, materials, predecessor activities, and required inspections. Record constraints, responsible personnel, and resolution deadlines.

Module 3 – Materials Control and Logistics

Link material requisitions to the schedule; record planned, received, rejected, and installed quantities, as well as remaining balances. Define receiving inspections, storage conditions, and traceability requirements for critical materials, in accordance with contractual requirements.

Module 4 – Quality at the Source

Develop inspection and test plans for each work activity, with acceptance criteria derived from design documents, specifications, and applicable standards. Identify hold points requiring approval before proceeding to the next stage. Record supporting evidence and responsible personnel.

Module 5 – Nonconformities and Rework

Record each occurrence, probable origin, impact, correction, action to prevent recurrence, and labor hours and materials used. Distinguish isolated corrective actions from actual rework, and approve closure only after technical verification.

Module 6 – Monitoring and Learning

Review indicators weekly and consolidate monthly analyses. Investigate significant deviations, prioritize corrective actions, and update planning. Maintain a record of decisions to enable comparisons across cycles and projects.

4.1 Proposed Decision-Making Flow

Before authorizing an activity, the coordinator verifies three conditions: (a) availability of technical requirements and current design documents; (b) confirmation of workforce, equipment, and materials; and (c) scheduling of inspections and dependencies. If any condition is not met, the activity remains on the constraint list, with an assigned responsible person and review date. Following execution, the team records production, consumption, and inspection results. Nonconformities are addressed before the dependent stage is authorized, according to the associated risk and contractual requirements.

4.2 Operational Indicators and Formulas

Indicator	Proposed Operational Definition	Frequency
Weekly Plan Completion (%)	$\text{Activities completed as promised} \div \text{activities promised} \times 100$	Weekly
Material Delivery Reliability (%)	$\text{Critical deliveries received by the required date} \div \text{planned critical deliveries} \times 100$	Weekly
Nonconformity Rate (%)	$\text{Inspections with nonconformities} \div \text{inspections performed} \times 100$	Weekly/monthly
Rework (hours/100 h)	$\text{Recorded rework hours} \div \text{total production hours} \times 100$	Monthly
Material Waste (%)	$\text{Quantity discarded due to loss} \div \text{quantity effectively made available} \times 100$, by material	Monthly
Schedule Deviation (days)	Actual milestone date minus planned date in the approved baseline	Per milestone

Each indicator must have an assigned responsible person, data source, audit rule, and exclusion criteria. Material comparisons require homogeneous units; indices should not be aggregated across different materials without a previously defined weighting methodology. Numerical targets should only be established after an initial diagnosis, without assuming universal values.

4.3 Minimum Documents Required for Replication

The protocol requires: project registration and responsibility matrix; baseline schedule and medium-term plan; constraint log; material receipt and consumption records; inspection

and test plan; nonconformity/rework form; daily production log; performance indicator dashboard; and review meeting minutes. Digital or printed templates may be used, provided that they maintain identification, version, date, and responsible person.

5. IMPLEMENTATION AND EVALUATION PLAN IN THE UNITED STATES

The proposed application should begin with a pilot project selected according to project size, contracting arrangement, and data availability. During the preparatory stage, the local team must identify state and municipal requirements, building codes adopted in the relevant jurisdiction, inspection requirements, contractual conditions, and activities reserved for licensed professionals or contractors. The model does not replace responsible engineers, mandatory inspections, or licenses required under applicable legislation.

A prospective evaluation design is suggested, comprising an initial observation period, assisted implementation, and subsequent monitoring. Before-and-after comparisons should control, whenever possible, for changes in scope, construction phase, team composition, production volume, and supply conditions. When multiple comparable projects are available, a comparison group and documentation of contextual differences are recommended. Analyses should present descriptive measures, data quality criteria, and limitations; causal inferences will not be appropriate without a compatible research design.

The expected outcomes constitute research hypotheses: greater visibility of constraints, improved material traceability, and earlier identification of deviations. The magnitude, and even the occurrence, of these effects will depend on future empirical validation. The transferability of Brazilian professional experience to the U.S. market must be demonstrated through implementation rather than assumed.

6. DISCUSSION

The conceptual contribution of the IPMQM lies in the explicit connection among activity readiness, material availability, inspection, and deviation recording. Rather than evaluating each function separately, the model proposes that a single activity should have documented criteria for authorization, execution, acceptance, and learning. The framework is consistent with the principles of reliable planning described by Ballard and Tommelein (2021) and the process-based management approach of ISO 9001:2026, without replacing these references.

The main limitation of the proposal is the absence of observed implementation at this stage. The professional documentation presented reports the author's participation in construction monitoring and materials control but does not provide historical indicator series, documentation of a previously implemented methodology, or evidence of results in the United States. Therefore, the research does not claim absolute originality of its components or proven cost reductions. Its preliminary contribution is operational systematization, whose novelty and performance must be examined in light of additional studies and practical implementation.

7. FINAL CONSIDERATIONS

This article presented the IPMQM as a technical and operational proposal to integrate planning, materials, quality, rework control, and performance evaluation in residential and commercial construction projects. The protocol details six modules, minimum records, a decision-making flow, and indicators with auditable definitions. The research provides a structured basis for future application in the United States construction industry, subject to adaptation to local regulatory requirements and the availability of teams and data.

The next step is to submit the model for the author's assessment, refine the forms, and conduct a documented pilot study. Only after this validation will it be possible to discuss measured effects on productivity, waste, quality, and schedule compliance. The text does not constitute evidence that a U.S. company has already been established or that the model has been commercially adopted.

Declaration of Artificial Intelligence Use: The authors declare that they used the generative artificial intelligence tool ChatGPT (OpenAI, GPT-5.5 model) during the preparation of this manuscript, exclusively to assist with grammatical revision, improvement of textual clarity, and linguistic organization of selected passages. The tool was not used to generate scientific data, produce research results, or replace the researchers' interpretation and critical analysis. All content prepared with the assistance of the tool was reviewed, verified, and validated by the authors, who assume full responsibility for the originality, accuracy, and scientific integrity of the work.

REFERENCES

- BALLARD, Glenn. The Last Planner System of Production Control. 2000. Doctoral dissertation — University of Birmingham, Birmingham, 2000. Available at: <https://etheses.bham.ac.uk/id/eprint/4789/>.
- BALLARD, Glenn; TOMMELEIN, Iris. 2020 Current Process Benchmark for the Last Planner System of Project Planning and Control. *Lean Construction Journal*, pp. 53-155, 2021. DOI: <https://doi.org/10.60164/47e7h7a1b>.
- INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO). ISO 9001:2026: Quality Management Systems — Requirements. Geneva: ISO, 2026. Available at: <https://www.iso.org/standard/9001>.
- LOVE, Peter E. D.; EDWARDS, David J. Determinants of rework in building construction projects. *Engineering, Construction and Architectural Management*, vol. 11, no. 4, pp. 259-274, 2004. DOI: <https://doi.org/10.1108/09699980410547612>.
- LOVE, Peter E. D. Quantifying the Costs of Field Rework in Construction. *Journal of Construction Engineering and Management*, vol. 152, no. 1, 2026. DOI: <https://doi.org/10.1061/JCEMD4.COENG-17026>.

BIOGRAPHY

Tomaz Lucas Souza Ferreira is a civil engineer who graduated from Faculdade Presidente Antônio Carlos de Teófilo Otoni, Brazil, in 2020. He has approximately five years of professional

experience in the construction industry, including construction planning, site monitoring and inspection, technical measurements, project documentation review, materials and services control, schedule monitoring, and quality control. His technical and academic interests focus on integrated construction management, operational efficiency, construction planning, waste reduction, and the improvement of project control and execution processes.

Tomaz Lucas Souza Ferreira é engenheiro civil, graduado pela Faculdade Presidente Antônio Carlos de Teófilo Otoni, Brasil, em 2020. Possui aproximadamente cinco anos de experiência profissional na construção civil, com atuação em planejamento, acompanhamento e fiscalização de obras, interpretação de projetos, medições técnicas, controle de materiais e serviços, monitoramento de cronogramas e controle da qualidade. Seus interesses técnicos e acadêmicos concentram-se na gestão integrada de obras, eficiência operacional, planejamento da construção, redução de desperdícios e aprimoramento dos processos de controle e execução de empreendimentos.

