Journal of Information Systems Engineering and Management
2025, 10(40s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

ERP-Integrated Inventory Control and Profitability in Construction: A Case Study

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ARTICLE INFO

Received: 31 Dec 2024

Revised: 20 Feb 2025

Accepted: 28 Feb 2025

ABSTRACT

In the construction industry, materials account for a significant portion of project costs and timelines, yet material management practices remain largely underdeveloped compared to other sectors. Enterprise Resource Planning (ERP) systems, while widely adopted in manufacturing and retail, have not been fully leveraged in construction, particularly for integrated inventory control. This study aims to examine how ERP-integrated inventory control models influence project profitability and performance in the construction sector. A mixed-methods approach was employed, comprising a preliminary survey of 100 Ahmedabad-based construction firms to assess ERP adoption trends, followed by an in-depth case study of a mid-sized construction company using an ERP software. Data were collected through structured interviews with key stakeholders involved in material management operations. The findings highlight improvements in procurement planning, inventory visibility, and cost control. However, critical limitations were identified, including lack of analytical tools (e.g., ABC/VED classification), manual data handling, poor user compliance, and insufficient system integration with accounting processes. The research underscores that technological adoption alone is insufficient; successful ERP utilization requires data discipline, user engagement, and customization aligned with construction workflows. The study provides practical recommendations for enhancing ERP system effectiveness and contributes to bridging the gap between theoretical ERP frameworks and real-world applications in construction. The implication is clear: to realize true profitability gains, ERP systems must evolve from passive record-keeping platforms into active drivers of decision-making and operational excellence.

Keywords: ERP Systems, Inventory Control, Construction Management, Material Management, Project Profitability.

INTRODUCTION

Materials are an integral part of any construction project. When talking about the cost share of the materials in any project, it generally ranges from 50-60% (Castro-Lacouture and Skibniewski, 2003). A study done by (Marsh, 1985) highlighted that overall the construction industry invests 0.15% of its cost in the material management, while manufacturing industry invests 1%. Hence, a discrepancy was always there between the portion of the cost material holds in a particular project while the organization's investment behind managing it.

While many of the organizations, especially Ahmedabad-Gandhinagar construction organizations use manual or traditional methods to manage inventories such as dead stock registers, physical bills and receipts while few of the mid-sized companies uses excel and similar tools to manage the inventory. While, growing and large construction contractors are shifting towards use of Enterprise Resource Planning (ERP) Software.

According to (Statista, 2024) The Indian construction industry is increasingly adopting ERP (Enterprise Resource Planning) software to manage complex projects and resources, with the market projected to reach $815.62 million by 2025 and a CAGR of 9.14% between 2025 and 2029.

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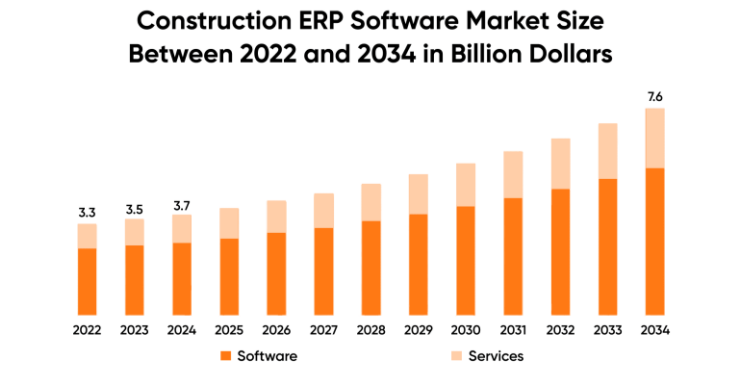

Figure 1 – Construction ERP Software Market Size

Though, ERP is seen as an expensive investment (Hadidi, Assaf and Alkhiami, 2017). Enterprise Resource Planning (ERP) systems can be referred as digital platforms, which are capable of integrating fragmented workflows, automating demand forecasting, and enabling real-time decision-making. Yet, despite their proven success in manufacturing and retail, ERP systems remain underutilized in construction, particularly in harmonizing inventory management with project-specific needs.

The gap between technological potential and practical application forms the base of this research. While prior studies have explored ERP adoption in construction (Kamlesh and Bhusawal, 2019) (Hadidi, Assaf and Alkhiami, 2017)(Swaranjali and Pathak, 2017) or standalone inventory models (Farhat and Owayjan, 2017) (Soni, Pitroda and Bhavshar, 2016), few have investigated how ERP-integrated inventory control systems can directly enhance profitability through cost savings, waste reduction, and operational efficiency (Feng and Zhang, 2010) (Shardeo, 2015) (Deepak and Kumar, 2016) (Sindhu, Nirmalkumar and Krishnamoorthy, 2007).

Although a few studies have explored ERP adoption in the construction sector, limited research has focused on identifying the root causes that directly impact key project parameters such as time and cost—particularly profitability.

This study aims to bridge this gap by presenting case studies from construction organizations in Ahmedabad, highlighting the pressing need for upgrading ERP-integrated inventory control models specifically tailored for building construction. It further evaluates the impact of such integration on profitability and project completion timelines.

Strategically aligning ERP systems with inventory control mechanisms can significantly enhance project outcomes. Nevertheless, challenges such as high implementation costs, employee resistance, and insufficient sector-specific customization continue to impede the widespread adoption of these systems.

In the following sections, we review existing literature on inventory control and ERP systems, detail the methodology for developing and testing the proposed model, present empirical findings from the case study, and discuss implications for both academia and industry.

LITERATURE REVIEW

This literature review is systematically organized to explore existing research on the three core themes of this study: (1) materials management and inventory control techniques, (2) enterprise resource planning (ERP) systems, and (3) their impact on construction project cost and time. A keyword-based filtering methodology was adopted to select scholarly articles, industry case studies, and empirical reports relevant to these themes. To ensure comprehensive coverage, the literature is categorized into four thematic clusters: (1&2) integration of materials management and ERP systems, (1&3) materials management and project performance, (2&3) ERP systems and cost-time impact, and (1,2,3) comprehensive studies encompassing all three dimensions. This approach not only deepens the understanding of each individual domain but also reveals gaps at their intersections, thereby justifying the need for the present study. Figure 2 represents the conceptual diagram.

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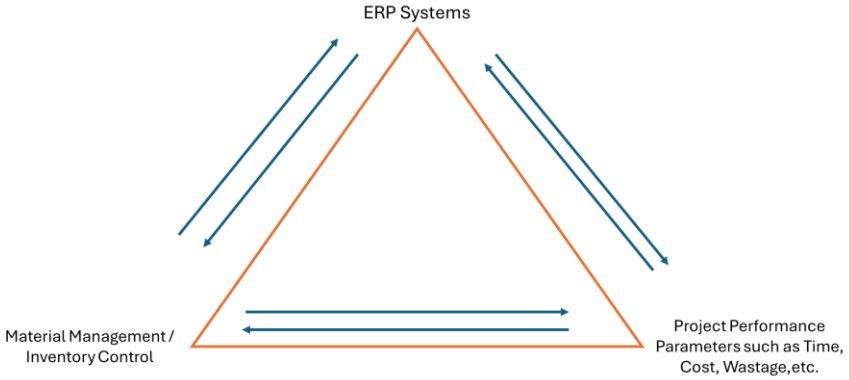

Figure 2 – The Trending Material Management Triangle

1. Studies on Materials Management and Inventory Control Techniques in Construction

Effective material management is essential in the construction industry, where materials constitute approximately 50–60% of total project cost and influence nearly 80% of schedule performance (Ibn-Homaid, 2002). (Zomerdijk and de Vries, 2003) proposed an organizational perspective on inventory control, extending beyond traditional order quantity and replenishment models. Their study emphasizes the influence of contextual factors—such as task allocation, decision-making, communication, and behavior—on inventory performance.

(Polat and Arditi, 2005) compared Just-in-Time (JIT) and Just-in-Case (JIC) systems through a simulation study and concluded that JIT systems, while theoretically efficient, may not be cost-effective in developing countries with supply chain uncertainties and market volatility.

(RathinaKumar *et al.*, 2018) demonstrated the practical benefits of tools like S-curve analysis, ABC classification, and EOQ in improving inventory planning and reducing costs by up to 35%. These studies collectively underscore the importance of adopting context-sensitive and technically robust inventory control methods.

2. Studies on ERP System Adoption and Implementation in Construction

ERP systems aim to integrate core business processes and foster transparency across departments. (Rolland and Prakash, 2000) discussed the challenges in aligning SAP's Material Management (MM) modules with organizational needs. Their study revealed structural mismatches due to differing abstraction levels between ERP software and organizational objectives.

(Mandal and Gunasekaran, 2003) provided a detailed case study on SAP R/3 implementation, highlighting the importance of phased deployment, change management, and training. Similar challenges were observed by (Hadidi, Assaf and Alkhiami, 2017), who developed a benefit-driven methodology to prioritize ERP module deployment, with inventory control, procurement, and project finance being the most strategic.

(Raibole and Waghmare, 2019), through case studies, used the Relative Importance Index (RII) to illustrate that material management has the greatest impact during the planning phase, further emphasizing the need for digital tools like SAP for improved transparency and cost tracking.

3. Studies Integrating Materials Management with ERP Systems

Several studies have explored the combined application of ERP systems and materials management for enhanced project outcomes. (Feng *et al.*, 2005) developed a periodic-review inventory model integrating multiple delivery modes and forecast updates, offering insights into base-stock policies and demand variability.

(Vishwakarma and Satao, 2015) demonstrated how customization of SAP's MM module improved inventory and procurement processes in the power sector. (Swaranjali and Pathak, 2017) emphasized ERP's role in streamlining procurement, inventory tracking, and interdepartmental communication.

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(Farhat and Owayjan, 2017) introduced a novel ERP–Artificial Neural Network (ANN) integration model to enhance inventory forecasting and responsiveness under dynamic scenarios. These studies highlight the growing trend of combining ERP with AI and analytics for intelligent material planning.

4. Studies on the Impact of Materials Management and ERP on Project Performance

(Shardeo, 2015) explored the financial impact of inventory turnover in manufacturing firms, demonstrating a strong correlation with profitability. (Jusoh and Kasim, 2016) reviewed 28 studies to establish material management's significant influence on time, cost, quality, and productivity. (Deepak and Kumar, 2016) applied ABC analysis, EOQ, and S-curve tracking to illustrate how structured inventory planning improves material flow and reduces costs.

(Gavali and Halder, 2020) identified 14 Critical Success Factors (CSFs) in ERP implementation, with top-ranking factors including software management, top management support, and team composition. Their findings reinforce the need for holistic planning and integration of digital tools in construction operations.

Summary of literature findings

A cumulative review of literature (Shah and Shah, 2023) revealed that while most studies (68%) prioritize project cost and 60% emphasize time, aspects like quality, waste reduction, and productivity remain underexplored. The table below synthesizes these performance parameters across key studies:

Table 1: Summary of Literature which have worked on Project Performance

Sr. No.	Authors	Criteria for Project Performance				
		Cost	Time	Quality	Waste	Productivity
1	(Gulghane and Khandve, 2015)	✓	✓	✓	✓	✓
2	(Alanjari, Razavialavi and Abourizk, 2014)	✓	✓		✓	✓
3	(Barry, Leite and O'BRIEN, 2014)	✓	✓	✓		
4	(Caldas et al., 2015)	✓	✓	✓		
5	(El-Gohary and Aziz, 2014)					✓
6	(Hughes and Thorpe, 2014)	✓	✓			✓
7	(Kar and Jha, 2020)	✓	✓			
8	(Xie and Palani, 2018)	✓				
9	(Gurmu, 2020)					✓
10	(Nagapan, Abdul Rahman and Asmi, 2012)	✓	✓		✓	
11	(Aziz and Hafez, 2013)	✓				
12	(Patil and Pataskar, 2013)	✓	✓	✓		✓
13	(Raibole and Waghmare, 2019)	✓	✓			
14	(Deepak and Kumar, 2016)	✓				

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Sr. No.	Authors	Criteria for Project Performance				
		Cost	Time	Quality	Waste	Productivity
15	(Meng, 2012)	✓	✓			
16	(Navon and Berkovich, 2006)	✓	✓			
17	(Caldas et al., 2015)	✓	✓			
18	(Jusoh and Kasim, 2016)	✓	✓	✓	✓	✓
19	(S. Pal and Ahire, 2016)	✓				
20	(Shardeo, 2015)	✓				
21	(Safa et al., 2014)	✓	✓		✓	
22	(Koushki and Kartam, 2004)		✓			✓
23	(Torrent, Caldas and Asce, 2009)					✓
24	(Nanaware and Prof.Saharkar, 2017)	✓				
Total		17	15	5	5	8

(Shah and Shah, 2023) described another table that which literature has done what in terms of implementation of ERP.

Table 2: Summary of Literature who have worked on ERP Implementation

Sr.No.	Author	Work Summary
1	(Rolland and Prakash, 2000)	overview of SAP R/3 and seven components of material management were explained.
2	(Razi and Tarn, 2003)	performed research for Fortune 500 businesses to develop an inventory management model for periodic review. A slow-moving spare component concept was suggested in their research.
3	(Zeng and Skibniewski, 2013)	Using fault tree analysis to provide probabilistic risk assessments for ERP system installation projects.
4	(Negahban, Baecher and Skibniewski, 2012)	Research on SMSCOs found that ERP adoption was doomed from the beginning.
5	(Hewavitharana and Perera, 2019)	They conducted a study to bridge the GAP between the construction industry process and ERP.
6	(Kamlesh and Bhusawal, 2019)	Case study of ERP system on a High-rise building project of Mumbai.

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Sr.No.	Author	Work Summary
7	(Sahari, Tinggi and Kadri, 2012)	studies the link between inventory management and business performance and capital intensity using financial data from 82 Malaysian construction companies between 2006 and 2010.
8	(Swaranjali and Pathak, 2017)	gave significant 14 benefits such as Efficiency, Forecasting, Collaboration, Scalability, Cost savings, Integrated Information systems, etc.,
9	(Vishwakarma and Satao, 2015)	case study of ERP software with customization for Chhattisgarh State Electricity Board, a state-owned electricity business (CSEB)
10	(Wang et al., 2013)	examines three critical facets of foundry materials management: material resource planning, material procurement, and material inventory
11	(Mukti, Tripathi and Rawani, 2014)	In ERP deployment, a conceptual model included success criteria and success indicators.

Research gaps and rationale for current study

Despite substantial work on ERP and material management independently, their integrated application—particularly in relation to profitability and project timelines in the construction industry—remains underexamined. Limited research has evaluated the effectiveness of ERP-integrated inventory control models in real-time environments or quantified their return on investment. Additionally, challenges in ERP customization and misalignment with construction-specific workflows continue to hinder adoption.

This study bridges these gaps by analyzing ERP-integrated inventory control models tailored for the construction sector and evaluating their impact on profitability and project performance through case-based empirical analysis.

RESEARCH METHODOLOGY AND DATA COLLECTION

This research adopts a mixed-methods approach, combining a quantitative survey and qualitative case study to investigate the impact of ERP-integrated inventory control models on construction project performance. The methodology is structured into a three-step framework comprising preliminary data collection, sample size determination, and case study selection.

Preliminary survey

A preliminary survey was conducted to identify the level of ERP adoption among construction firms in Ahmedabad. The survey targeted firms with a turnover exceeding ₹10 crore, considered more likely to utilize ERP systems due to their operational scale. A total of 100 companies responded positively, indicating that they have implemented ERP systems in some form. This initial dataset formed the basis for defining the sample population and planning the case study selection.

Sample size determination

To ensure statistical validity in selecting case study participants, Cochran's formula was employed to calculate the minimum required number of survey responses:

$$n_0 = \frac{Z^2\, p\, q}{e^2}$$

Where:

- $n_0 =$ Required sample size (for an infinite population)
- $Z =$ 1.96 (for a 95% confidence level)

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- p = 0.5 (assumed proportion of population for maximum variability)
- q = 1 − p = 0.5
- e = 0.10 (margin of error = 10%)

Substituting the values:

$$n_0 = \frac{Z^2\, p\, q}{e^2} = \frac{(1.96)^2\, 0.5\, 0.5}{0.1^2} = 96.04$$

Since the total population is finite (N = 100 companies), the sample size is adjusted using the finite population correction:

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} = \frac{96}{1 + \frac{96 - 1}{100}} = \frac{96}{1.95} = 49.23 \text{ (Considering 50)}$$

Thus, a minimum of 50 valid survey responses are required to ensure a statistically significant selection base for case study sampling.

Case study selection framework

The goal of this study is to conduct 15 in-depth case studies through structured interviews. However, not all survey respondents are typically willing or suitable to participate in detailed interviews. Assuming a 30% selection rate (i.e., 3 out of every 10 companies are interview-ready), the number of required survey responses can be estimated as:

$$\text{Required survey responses} = \frac{15}{0.3} = 50$$

This confirms the sample size derived from Cochran's formula and ensures a robust base for qualitative analysis. For the purpose of this research paper, one representative case study is presented in detail to illustrate the application and impact of ERP-integrated inventory control models. The selected case study represents a mid-to-large-scale construction organization with a turnover exceeding ₹10 crores, offering rich insights into ERP system implementation, inventory control strategies, and their influence on cost optimization and project timelines.

This hybrid methodology—survey-based trend analysis followed by detailed case study interpretation—enables a comprehensive understanding of both industry-wide practices and firm-level operational impacts.

Case Study: ERP-Integrated material management in practice

To gain a comprehensive understanding of ERP-integrated material management processes in practice, an in-depth case study was conducted at a mid-to-large-scale construction company based in Ahmedabad, established in 2008. The company employs A Construction ERP, a specialized ERP platform originally developed for internal use by their own construction firm and later commercialized by them across the Indian construction Market.

Overview of ERP Deployment at Selected Construction Firm

The following modules are actively used at the Construction Company selected for the case study:

- Tenders & Contract Management
- Accounts Module
- Human Resources Module
- Material Management & Inventory Control Module
- Vendor & Client Management Module

Each module supports a specific function, with further customization offered through ERP's low-code development platform, facilitating digital transformation across core business functions.

User-Centric Process Mapping and Data Collection

Structured interviews were conducted with key stakeholders including:

- The Company Owner

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- Purchase Manager
- Junior Purchase Manager
- Project In-charge
- Junior Site Engineer
- Store Keeper

These interviews helped uncover the exact workflow and user-level challenges across four major ERP-integrated material management stages: Material Purchasing, Material Receiving, Material Assignment & Use, and Material Billing.

Material Purchasing Process Flow

1. Purchase Order Creation: Initiated by junior staff; P.O. number is generated at the Head Office.
2. Level 1 Verification: Reviewed based on material specification, quantity, vendor details, and delivery schedule.
3. Level 2 Approval: Final verification by the Owner, primarily focused on vendor credibility and rate negotiation.
4. Purchase Order Dispatch: Approved P.O. is sent to the vendor.

Identified Challenges:

- Lack of coordination between junior purchase staff and site-level decision-makers (usually project managers).
- Approval delays due to multi-level processing; e.g., if Owner is unavailable, P.O. remains unapproved in ERP.
- No system-based visibility of previous purchase data during new P.O. creation; manual tracking is required.
- In some cases, orders are placed directly via phone calls and later entered in ERP—making the system a mere data-entry tool rather than a real-time decision support system.

Material Receiving Process (MRN - Material Receipt Note)

1. Materials delivered onsite are accompanied by physical challans.
2. Site personnel generate MRN entries in ERP.
3. Level 1 Verification: MRN data is manually verified against the P.O. and physical challan.

Identified Challenges:

- No provision to upload scanned copies of physical challans; increases risk of manipulation or data errors.
- Manual entry and back-dating required if MRN is not updated on the same day.
- Loss of physical challan leads to non-traceable discrepancies.
- For open P.O.s, remaining quantity does not automatically return to the budget unless explicitly closed in ERP

Material Assignment & Use

Materials received are allocated to specific construction activities through ERP, which are pre-defined in the Budget/Planning module.

Identified Challenges:

- Site staff often unwilling or lack time to perform ERP-based activity assignments.
- ERP does not flag errors if assignment is skipped, leading to data inconsistency.
- No accurate material-to-activity mapping maintained, resulting in poor budget control and tracking

Material Billing and Payment

1. Vendor bills are submitted and matched against the Purchase Order.
2. Bill data is verified and approved through Level 1 and Level 2 approvals.
3. Payment clearance is coordinated with the accounts department

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Identified Challenges:

- ERP does not support partial billing against a single P.O. (e.g., two bills of 500 bags each against a 1000-bag P.O.).
- No feature to upload scanned copies of vendor bills for verification.
- Manual tracking is required to identify pending P.O.s and billing discrepancies.
- If budget quantity becomes negative due to mismatched billing, ERP throws errors without proactive alerts.
- Lack of integration between purchase and accounts modules for seamless payment processing

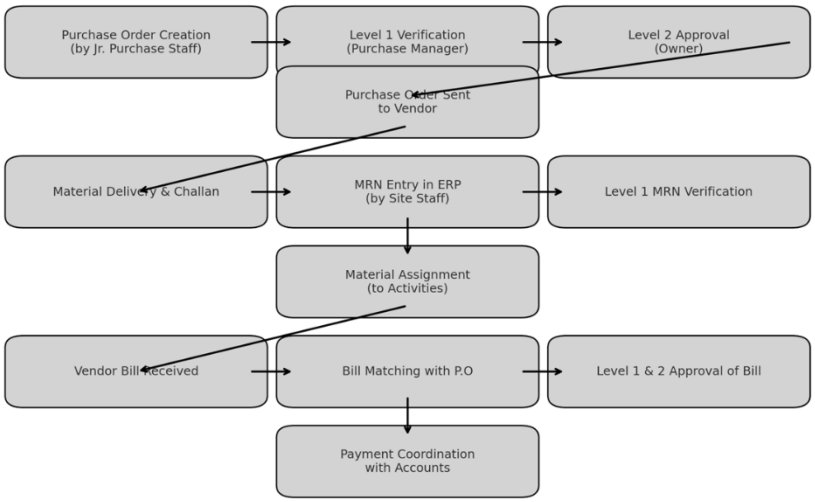

Figure 3: Conceptual diagram of the ERP-Integrated Material Management Process Flow

Note: Due to organizational confidentiality policies, screenshots of the ERP system could not be included in this paper. However, the organization has issued an official declaration confirming the authenticity and accuracy of all ERP process data and case study findings.

Summary of Observed Issues and Process Inefficiencies

Table 3: Summary an Observations

Process Area	Key Challenges Identified
Purchase Order Creation	Approval delays, manual tracking, lack of auto-fetch of past data
Material Receipt	No challan scanning, delayed entries, poor tracking of open P.O.s
Assignment & Use	Low user engagement, optional entry, lack of ERP validation checks
Billing & Payment	No partial billing, no bill uploads, manual tracking, poor ERP-Accounts sync

RESULTS

While the ERP system at the construction company, significantly streamlines core procurement and inventory workflows, several operational bottlenecks and system-level limitations hinder its full potential. The study underscores the need for improved user training, better integration of scanning/document upload features, and automated budget linking mechanisms to enhance ERP functionality and achieve measurable gains in project efficiency, material cost control, and accountability.

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The objective of this research was to critically examine the impact of ERP-integrated inventory control systems on project profitability and performance in the construction industry. Through a structured literature review and a detailed case study, the study highlighted both the transformative potential and the prevailing limitations of ERP systems in real-world construction operations.

The findings reveal that while ERP adoption offers numerous benefits—such as improved procurement planning, enhanced material visibility, and cost control—its success is largely dependent on the accuracy of data input, user engagement, module customization, and system integration. The case study further demonstrated that challenges such as limited analytical capabilities, backdated data manipulation, manual tracking efforts, and lack of accountability frameworks continue to hinder the full realization of ERP's potential in construction environments.

The study contributes to the body of knowledge by mapping the intersection of materials management, ERP functionalities, and project performance metrics. It underscores the necessity for organizations to move beyond mere digitization toward a more strategic and data-driven ERP ecosystem that supports real-time decision-making, cost optimization, and productivity enhancement.

In addition to identifying functional gaps, the research offers actionable recommendations including the integration of analytical tools like ABC-VED analysis, introduction of automated alerts, implementation of role-based controls, and improved inter-module connectivity. These measures are essential for ensuring ERP systems evolve from record-keeping tools to powerful drivers of operational excellence.

As a future direction, there is a need to conduct broader multi-case studies supported by quantitative performance data and industry benchmarking. Integration of AI-based predictive models, IoT-linked inventory tracking, and cloud-based ERP systems may further enhance efficiency and adaptability in the construction sector. By leveraging such technologies and addressing organizational barriers, the construction industry can realize the full value proposition of ERP-integrated material management systems

DISCUSSION

The case study revealed multiple practical insights into the implementation and real-world functioning of ERP-integrated material management systems in the construction sector. While ERP adoption has enabled process digitization and improved interdepartmental visibility to an extent, several critical limitations and operational challenges continue to hinder its full effectiveness.

Systemic and Functional Limitations

1. Dependency on Timely Data Entry and Accuracy

The effectiveness of ERP systems is highly dependent on the accuracy and regularity of data updates. Field observations revealed that material-at-site tracking was significantly compromised due to inconsistent data entry by site personnel. Without timely data, even the most advanced systems fail to reflect real-time ground realities.

2. Lack of Analytical Tools (e.g., ABC, VED Analysis)

The current ERP system does not have built-in functionality to automatically classify materials using techniques like ABC (Always Better Control) or VED (Vital, Essential, Desirable). These tools are essential for inventory prioritization, cost optimization, and criticality-based procurement strategies.

3. Limited Reporting Capabilities

While some basic reports are available (e.g., Purchase vs. Budget reports), the quantity and quality of material-related reports are inadequate. Report formats are unstructured and often require substantial post-processing in Excel or other software to make them usable for decision-making or stakeholder presentations.

4. Vulnerability to Backdated Manipulation

A key concern observed is the system's flexibility to allow backdated entries, enabling users to generate purchase orders or material entries with altered dates or revised budget figures. This compromises auditability, data integrity, and transparency, which are among the core objectives of ERP adoption.

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5. Absence of Wastage Tracking and Control Measures

The ERP system does not include any standardized mechanism to record or analyze material wastage, nor is there any organizational practice enforcing such data capture. This omission results in invisible loss of materials, contributing to cost overruns and affecting overall project profitability.

6. Manipulation-Prone Environment

Since data modifications are easily possible—such as changing material quantities, budget figures, or bill approvals post-entry—there exists a potential risk of deliberate or unintentional data manipulation, making the system less reliable as a performance monitoring tool.

Organizational Behavior and User Adoption Issues

7. Low Motivation and ERP Usage at Site Level

Despite the availability of modules, site-level staff often showed reluctance or lack of time to enter or update ERP data. Material assignments to specific project activities were often skipped, as the system did not enforce validation checks or error alerts, leading to poor tracking against the budgeted plan.

8. Redundancy in System Usage

In several instances, it was observed that verbal orders are placed directly with vendors, and ERP entries are made later merely to maintain records. This approach reduces the ERP to a post-facto documentation tool rather than a proactive management system.

9. Lack of Integration with Accounting Module

Even after bills are cleared in ERP, manual follow-up is required with the accounts team to initiate payment processing, indicating a weak inter-module integration that delays financial closure and hinders workflow automation.

10. Absence of Alert Mechanisms

The system does not generate automatic alerts or warnings for pending purchase orders, negative budget balances, or duplicate billing entries. Such proactive system intelligence is essential to minimize oversight and reduce errors.

Interpretation in Context of Literature

These findings are consistent with broader literature that identifies ERP system success not merely as a technological function but as a combined outcome of system design, user behavior, process alignment, and organizational culture (Hadidi, Assaf and Alkhiami, 2017; Gavali and Halder, 2020).

While ERP adoption is a step toward process standardization, the real performance improvement emerges only when supported by analytical reporting tools, strict data governance, staff training, and policy enforcement. The findings reinforce the need for customized ERP module enhancements, such as:

- Embedded ABC/VED analysis tools
- Auto-validation checks for material assignment
- Integrated document scanning options for challans and invoices
- Role-based user access control with audit trails

Recommendations

Based on the analysis of ERP-integrated material management practices at the selected construction company, several targeted recommendations are proposed to enhance the system's effectiveness and align it with construction project goals. These recommendations span across technological upgrades, process improvements, and user engagement strategies.

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Journal of Information Systems Engineering and Management
2025, 10(40s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

System Enhancement Recommendations

- Incorporate ABC and VED classification tools within the ERP to facilitate material criticality-based procurement planning and inventory control.
- Introduce document scanning and upload functionalities for challans and vendor bills to improve data authenticity and reduce manipulation risks.
- Implement validation checks to ensure material assignment against planned activities is not bypassed.
- Enable automated alerts and notifications for pending purchase orders, bill mismatches, and budget over-runs.
- Restrict backdated data modifications by enabling role-based access control and audit trails.

Process and Policy Improvements

- Mandate timely and real-time data entry, especially for material receipt and usage records, with accountability frameworks for site personnel.
- Improve inter-module integration (ERP and Accounts) for seamless bill processing and payment clearance.
- Establish wastage tracking mechanisms to quantify material loss and incorporate into budget planning.
- Conduct periodic ERP training workshops for all hierarchical levels to improve user familiarity and data discipline.

Summary Table – Findings, Consequences, and Recommendations

Table 4: Key finding, consequences and recommendations

Key Finding	Operational Consequence	Recommended Solution
Inconsistent data entry by site staff	Inaccurate material-at-site visibility	Enforce real-time data entry protocols with user accountability
No ABC/VED classification available	Lack of material prioritization	Integrate ABC-VED tools in ERP
Limited and unstructured report formats	Difficulty in strategic analysis	Redesign report formats and automate structured reporting
Backdated data modification possible	Data manipulation and audit risks	Implement role-based control with timestamp locking
No tracking of material wastage	Hidden cost overruns	Introduce mandatory wastage logging feature
ERP used post-facto after verbal orders	System redundancy; loss of proactive control	Mandate P.O. generation before order placement
No scan upload option for challans/bills	Fraud risk and manual errors	Add digital document upload and verification system
Lack of ERP-to-Accounts module sync	Delay in payments, miscommunication	Improve inter-module integration workflow
No automatic alerts or warnings	Oversight of critical system updates	Deploy smart alert mechanisms for budget, billing, and open P.O. status

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