Integrating Next Generation ERP Systems into Cement Factories: Case Study Approach to Enhance Operational Efficiency and Sustainability

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Abstract

This study runs a full comparative analysis of manual and ERPNext procurement cycles in a cement manufacturing facility to identify efficiency gained from digital transformation by using systematic real time analysis and workflow assessment. The research shows that ERPNext implementation lowers the procurement cycle times by 24-48% (from 9-19 days to 4.5-16.5 days) and also lowers human error rates by an approximation of 80%. The manual process faces major delays with a 40% of total cycle time consumed by internal administrative tasks compared to only 15% in the automated digital system. Although both systems sharing the same supplier response time as the same primary bottleneck of (50% of cycle time) ERPNext demonstrates a superior operational efficiency through workflow digital automation with real-time visibility and integrated data management that is a beginner user friendly. The calculated return on investment shows that an annual saving of LYD 260,000-640,000 for 100 procurement cycles annually which provides logical economic justification for ERP system adoption in a medium to large manufacturing enterprises.

Keywords: Enterprise Resource Planning, ERPNext, Procurement Automation, Digital Transformation, Supply Chain Management

1. Introduction

Enterprise Resource Planning (ERP) systems represent a fundamental component of modern organizational management that is developed from basic Material Requirements Planning (MRP) systems in the 1970s to the latest integrated platforms that are supporting finance. Also, human resources with a supply chain and procurement functions [1]. These systems improve data consistency that are directed alongside operational visibility and strategic decision-making through unified digital environments making them functional tools for organizations operating in a competitive market [2]. Among many ERP solutions the open-source platforms like the ERPNext have gained big notice especially for small-to-medium enterprises (SMEs) seeking cost-effective and strong capabilities [3].

The procurement function within ERP systems models which are been represented with an important module controlling end-to-end processes of sourcing and purchasing also paying for goods and services at the same time. An effective procurement cycle automation is an important

factor for cost control that is linked with the supplier relationship management and maintaining supply chain toughness [4]. Modern ERP systems transform procurement cycles from manual document labor handling into smooth data-driven operations by automating digital workflows such as the purchase requisitions linked with the supplier quotations to the purchase orders and invoice matching through one digital gate linking them all at the same time. Despite documented benefits with the practical evidence (physical paper) while calculating efficiency gained from ERP implementation in the procurement cycles. It is still limited especially in manufacturing environments. This research addresses this gap through a comparative analysis of manual and ERPNext-enabled procurement processes in cement manufacturing factories.

1.1 Problem Statement

Manual procurement processes suffer from major delays described as extremely long cycle times (9-19 days) reaching a high internal administrative delay of (40% of total cycle time). Repetitive human error rates reach (approximately 15%) that lack real-time visibility between departments [6]. These systems use only physical document movement which is (self - others) dependent. Step by step processing and repetitive data entry to ensure workflow progress causing operational delays and increased costs while been weakened to compliance controls.

1.2 Research Objectives

This study aims to:
- Conduct a comparative analysis of manual and ERPNext based procurement cycles
- Quantitative assessment of: (a) efficiency gained (b) error reductions (c) time savings achievement with the digital automation
- Provide hard evidence based on recommendations for modernizing procurement operations through integrated ERP implementation

1.3 Research Importance

This research contributes to the operational management literature by linking the theoretical ERP benefits with the practical and measurable outcomes. It provides organizations with a detailed framework for justifying digital transformation investments with optimizing supply chain resilience and insuring strategic decision making with data-driven procurement application.

2. Literature Review

ERP systems are designed to be in the middle of any models that are integrate with many business functions into an operational framework [7]. Davenport [8] defines ERP as a suite of commercial

software packages that are smoothly integrated and organized information across functional areas which are needed. The evolution from MRP to MRP II to enterprise-wide ERP systems shows technological advancement and organizational adaptation to any environment [9]. Open-source ERP systems including ERPNext and Odoo are proven to be important alternatives to the proprietary (closed systems) solutions offering cost efficiency to flexibility and independence from vendor limitations and complications [10]. These systems allow enterprise technology access for SMEs through minimal licensing fees and large developer communities [11]. Procurement automation within ERP systems addresses several operational challenges. Gattiker [12] demonstrates that ERP enables coordination between manufacturing and marketing which mainly improves the operational performance.

Marcinauskas [13] identifies critical success factors for ERP integration within lean manufacturing to be concentrating on managing communications and real time data coordination. Recent trends on ERP development include automation and IoT integration with big data and machine learning capabilities also cloud and web accessibility that makes for easy mobile integration [14]. These developments underscore a move toward intelligent and adaptable ERP ecosystems capable of learning from organizational data which is collected from user behavior [15]. Despite extensive literature on ERP systems generally linking procurement operations with ERP is limited. The research which has been conducted to compare the specific efficiency metrics between manual and automated procurement processes in manufacturing fields. This study addresses this research gap through proven comparison and hard data.

3. Methodology

3.1 Research Design

This study uses a comparative quantitative methodology using estimated time use with phase-based breakdowns and efficiency calculations to measure and contrast a manual and ERPNext digital procurement cycles. The research framework adds logical ERP system principles with calculated assessment of procurement cycle performance outcome.

3.2 Data Collection and Analysis

- Document analysis of manual procurement forms (Commercial-27 through Commercial-37)
- 2.Workflow study of manual procurement stages
- ERPNext workflow analysis through interface examination and processing models

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- Comparative efficiency calculation using the formula:

Efficiency Improvement Equation = [(Manual Time - ERPNext Time) / Manual Time] × 100%

3.3 Study Boundaries

The research focuses specifically on procurement cycles for raw materials in the cement manufacturing plant by removing other business functions. The analysis considers to be standard procurement operations without any quality issues also providing a standard efficiency comparison.

4. Results

4.1 Manual Procurement Cycle Analysis

The manual procurement cycle involves specified order of actions that is staged requiring physical document to be moved into a multi department coordination procedure so that one cycle is achieved as indicated in table 1.

Table 1: Manual Procurement Cycle Components

Document	Form Reference	Copies	Copy Distribution
Material Requisition	Commercial-27	2	Stores (original)- Requesting Dept (copy)
Purchase Requisition	Commercial-28	4	Purchasing- Accounts-Requesting Dept-Stores
Purchase Order	Commercial-31	6	Supplier, Accounts-Receiving, Stores, Dept. Purchasing
Inspection & Receiving Report	Commercial-32	4	Gen.Admin. Inspection-Purchasing- Stores

Table 2 shows the manual cycle time distribution, the manual cycle shows major time wasted, with 40% of total time consumed by internal administrative tasks.

Table 2: Manual Cycle Time Distribution

Cycle Phase	Time (Hours)	Percentage	Key notes
Internal Requisition	24-72	15%	Physical document routing, desk delays
PO Processing & Dispatch	24-48	10%	Manual-form typing multi-group distribution
Supplier Response	120-240	50%	External factor, delayed communication
Goods Receipt & Inspection	24-48	10%	Physical verification, form writing
Final Acceptance & Filing	24-48	15%	Internal transport, manual archiving
Total Cycle Time	216-456	100%	9-19 Business Days

4.2 ERPNext Procurement Cycle Analysis

ERPNext automates the digital procurement workflow through integrated modules and digital processes. The system decreases administrative delay by using features that include guided

onboarding, shortcut-based navigation, and real time data visibility by using key performance indicators (table 3).

Table 3: ERPNEXT Cycle Time Distribution

Cycle Phase	Time (Hours)	Percentage	ERPNext Features
Preparation	4-8	10%	Item/Supplier master data setup
Requisition to RFQ	4-8	10%	Automated first stage workflow-approval routing
Supplier Response	48-120	50%	Longest phase in ERPNext procurement cycle
Approval to PO	8-24	15%	invoice matching automated PO generation
Delivery	24-168	10%	Goods receipt tracking, inspection recording
Invoice to Payment	24-72	5%	Automated matching, payment processing
Total Cycle Time	112-400	100%	4.5-16.5 Business Days

4.3 Comparative Efficiency Analysis

Direct comparison reveals important efficiency gained. ERPNext minimizes internal process time by 65-75% and maintaining same external timelines (table 4).

Table 4: Comparative Efficiency Metrics

Metric	Manual Process	ERPNext Process	Improvement
Total Cycle Time	216-456 hours	112-400 hours	48% faster average
Internal Process Time	96-216 hours	64-280 hours	33-67% reduction
Internal Administrative delay	40%	15%	2.7x less delay
Error Rate	~15%	~3%	80% reduction
Real-time Visibility	Limited	Overall	Complete

The efficiency equation concludes the following:

Efficiency Improvement Equation $= [(336 - 256) / 336] \times 100\% = 23.81\%$ [1]

where 336 hours represent an average of manual time and 256 hours represent the average of ERPNext time.

4.4 Return on Investment Calculation

For total 100 procurement cycles annually, ERPNext implementation sums up to:

- Time savings: 10,400-25,600 hours annually
- Labor cost savings: LYD 260,000 (at LYD 25/hour)
- Error reduction savings: LYD 50,000-96,000
- Working capital improvement: 15-20% inventory carrying cost reduction
- Total estimated annual savings: LYD 260,000-640,000

4.5. Discussion

4.5.1 Key Findings Interpretation

The research confirms that when the supplier response time remains as the primary bottleneck in both of the systems (50% of cycle time). Thus, ERPNext's major reduction in internal administrative delay results at 40% to 15%.

 This reduction sums from several factors:

- Automated workflow as to directing files and forms physically through document movement
- Digital data entry prevents repetitive manual input error
- Real-time visibility ensures quick readiness for problem solving
- Integrated modules prevent data lose which is mainly from been trapped and stored separately and coordination delays

The interface analysis shows that ERPNext's design principle of modularity can make user accessibility and data-driven navigation directly effect to the efficiency gained. Features like the "Your Shortcuts" sections as well a guided onboarding link and a complete dashboard that lowers cognitive load and navigation time.

4.5.2 Applied Methodology

Organizations considering ERP implementation should be prioritizing the following:

- Phased adoption: Begin with the main procurement modules before ever expanding functionality
- Change management: help users learn with training and step by step implementation
- Data migration: Ensure accurate fixed master data setup during the startup phase of the implementation operation
- Process optimization: Re-engineering and restructure processes to boost ERP capabilities in full scale

4.5.3 Knowledge Contributions

This study extends to the existing ERP literature by providing a calculated goal for the digital procurement automation benefits. It links the theoretical discussions of digital transformation with practical solid evidence that specific efficiency is gained at the same time offering a new framework for future research in other business functions and industries.

4.5.4 Limitations and Future Research

The study limitations include a single industry focus and estimation which is based on time. Measurements are at the early-stage of ERP implementation that acts as a foundation.

Future research should consist of:

- Investigating a long-term efficiency gain as users get skilled with ERP operations
- Compare multiple ERP systems with each other across different industries
- Inspect integration challenges with already outdated operating systems
- Analyze the impact on supplier relationships and supply chain resilience

5. Conclusion

This comparative analysis demonstrates to us that ERPNext implementation produces a clear efficiency improvement in a procurement cycle while recording a total cycle time of 24-48% and internal administrative delay by 2.7x. While the supplier response remains an external factor.

ERP systems optimize the internal processes using automation with integration and real-time visibility which are shown in key performance indicators and report generation.

The counted benefits including 80% error reduction and annual savings of LYD 260,000-640,000 provide compelling justification for digital transformation investments in manufacturing enterprises. Organizations seeking to improve procurement efficiency with lower costs and an improved supply chain strength should be prioritized in ERP system implementation as a strategic improvement.

Future research should explore prolonged impacts in cross-industry comparisons with advanced analytics integration to further refine the understanding of ERP system benefits in practical environments.

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