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Value Stream Mapping Analysis: Case Study of Project Report Management in a Coal Mining Company

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ABSTRACT

This research explores the application of Value Stream Mapping (VSM) and Lean Management principles to enhance project performance reporting efficiency at PT Borneo Bara, a coal mining company in South Kalimantan, Indonesia. The coal mining industry faces significant challenges in project management, particularly in maintaining accurate, timely, and standardized reporting systems that are critical for operational decision-making and regulatory compliance. The current manual reporting process at PT Borneo Bara is characterized by inefficiencies, including extended processing times, data inaccuracies, and inconsistent formatting, which collectively hinder effective project monitoring and stakeholder communication. This study employs VSM analysis to systematically identify bottlenecks and waste in the existing reporting workflow. Through comprehensive process mapping and stakeholder interviews, the research identifies key obstacles, including redundant approval processes, manual data entry errors, and lack of standardized templates. A digital reporting system with automated validation and centralized data management is proposed as a solution. Implementation results demonstrate substantial improvements: reporting cycle time decreased from 10.8 days to 5.25 days (a 51.3% reduction), process efficiency increased from 44.1% to 90.5%, and data accuracy improved from low to high levels. These findings validate the effectiveness of VSM and Lean principles in streamlining project report management processes in the mining industry, offering practical implications for operational excellence and digital transformation initiatives.

KEYWORDS *Digitalization, Lean Management, Project Performance Reporting, PT Borneo Bara, Value Stream Mapping*

INTRODUCTION

The global mining industry faces increasing pressure to enhance operational efficiency, improve decision-making processes, and maintain regulatory compliance in an increasingly complex business environment (Komljenovic, Loiselle, & Kumral, 2017). Project management in mining operations requires robust reporting systems that provide timely, accurate, and comprehensive information to support strategic and operational decisions (Shimaponda-Nawa, Nwaila, Zhang, & Bourdeau, 2023). According to the International Council on Mining and Metals (ICMM), effective project reporting is fundamental to achieving sustainable mining practices and maintaining stakeholder trust (Crous & Marais, 2025). However, many mining companies, particularly in developing economies, continue to rely on manual reporting processes that are prone to inefficiencies, delays, and errors (Sishi & Telukdarie, 2020).

In the Indonesian mining sector, which contributes significantly to the national economy, project management challenges are particularly acute (Nazir, Murdifin, Putra, Hamzah, & Murfat, 2020). The Ministry of Energy and Mineral Resources reported that inefficient administrative processes, including project reporting, contribute to an estimated 15-20% productivity loss across the mining industry (Pienaar, 2018). These inefficiencies manifest in delayed decision-making,

resource misallocation, and compromised stakeholder communication (Maani, 2016). The coal mining subsector, which represents a substantial portion of Indonesia's mineral exports, is especially vulnerable to these challenges due to the scale and complexity of operations.

PT Borneo Bara, a leading coal mining company operating in South Kalimantan, exemplifies these industry-wide challenges. The company's current manual reporting system is characterized by several critical inefficiencies: extended processing times averaging 10.8 days per reporting cycle, frequent data inaccuracies requiring multiple revisions, and inconsistent formatting that complicates data interpretation. These issues directly impact operational efficiency, as defined by Atkinson as the optimal utilization of resources to achieve project objectives within time, cost, and quality parameters (Zidane & Olsson, 2017). The relationship between these variables is interconnected: inefficiency in reporting processes leads to reduced accuracy, which in turn affects timeliness, ultimately necessitating digital transformation as a systematic solution (Avinash & Joseph, 2024).

The urgency of addressing these challenges is underscored by recent industry developments. The COVID-19 pandemic has accelerated the need for digital transformation in mining operations, with remote work requirements exposing the limitations of manual processes (Amankwah-Amoah, Khan, Wood, & Knight, 2021). Furthermore, increasing regulatory requirements from Indonesia's Ministry of Energy and Mineral Resources demand more frequent, detailed, and accurate project reporting (Ali & Kim, 2024). Failure to address these inefficiencies risks operational delays, regulatory non-compliance, and competitive disadvantage in an increasingly digitalized industry (Jahidi, Danuri, & Abd Karim, 2024).

Previous research has demonstrated the effectiveness of Lean Management principles and *Value Stream Mapping* (VSM) in addressing operational inefficiencies across various industries (Andreadis, Garza-Reyes, & Kumar, 2017). Lasa evaluated VSM as a diagnostic tool for identifying waste in business processes, while Seth and Gupta demonstrated its application in reducing cycle times in manufacturing (Seth, Seth, & Dhariwal, 2017). In the construction sector, Simamora et al. (2023) successfully applied VSM to identify waste in electrical transmission infrastructure projects, achieving significant efficiency improvements. However, limited research has specifically examined the application of *VSM* to project reporting processes in the coal mining context, particularly in Indonesian operations where unique organizational and regulatory factors influence process design (Indriati, Rasi, Setiaji, & Hadiwinata, 2023).

This research addresses this gap by investigating how *VSM* and Lean Management can systematically improve project performance reporting in coal mining operations. The novelty of this study lies in three key aspects: (1) the specific application of *VSM* to administrative processes (project reporting) rather than physical production processes in mining; (2) the integration of digital solutions with Lean principles to achieve comprehensive process transformation; and (3) the development of a standardized reporting framework tailored to the coal mining industry's specific requirements. Unlike previous studies that focused primarily on manufacturing or construction, this research examines the unique challenges of mining project reporting, including

multiple stakeholder coordination, complex data validation requirements, and regulatory compliance considerations.

The objectives of this research are threefold: (1) to analyze the factors affecting reporting timeliness through comprehensive *VSM* analysis; (2) to identify root causes of data inaccuracies using Lean diagnostic tools; and (3) to design and evaluate a standardized digital-based reporting format that addresses identified inefficiencies. The benefits of this research extend to multiple stakeholders: mining companies can adopt the proposed framework to enhance operational efficiency; project managers gain insights into waste elimination strategies; and industry practitioners receive evidence-based guidance for digital transformation initiatives. The implications are particularly relevant for Indonesian mining companies facing similar challenges, offering a replicable model for process improvement that balances technological innovation with practical implementation considerations in resource-constrained environments.

METHOD

This study employed a descriptive case study approach with a mixed-methods design to investigate and improve project performance reporting processes at PT Borneo Bara, a coal mining company in South Kalimantan, Indonesia, specifically in Tanah Bumbu Regency. The research covered a six-month period from January to June 2024, capturing the full reporting cycle of multiple projects to ensure comprehensive data collection. The case study methodology followed Yin's (2018) framework, enabling an in-depth investigation of contemporary phenomena within real-life contexts, suitable for analyzing complex organizational processes.

The research design adopted a sequential exploratory approach, starting with qualitative data collection to understand the existing reporting process, followed by quantitative measurement of process parameters, and concluding with the development and evaluation of improvement solutions. This combined approach allowed analysis of both process mechanics and stakeholder perspectives, addressing the multidimensional challenges in project reporting.

Primary data were collected through three complementary methods to ensure reliable coverage. Semi-structured interviews were conducted with 15 key informants: 5 employees responsible for daily report preparation, 5 supervisors overseeing data compilation and validation, 3 representatives from PT Borneo Bara's project management office, and 2 senior managers involved in strategic decisions. Interview protocols were based on the Value Stream Mapping (VSM) framework, focusing on process steps, time requirements, information flow, and pain points. Interviews lasted 60-90 minutes, were audio-recorded with consent, and transcribed for thematic analysis.

Direct field observations covered 20 complete reporting cycles to document actual process flows, timing, and workflows. Protocols included time-motion studies measuring processing versus waiting times, document flow tracking from data collection to final approval, and identification of bottlenecks and handoff points. Field notes used standardized forms for consistency.

Historical reports from 50 prior cycles were reviewed to extract quantitative data on cycle times, revision frequencies, error types, and format variations, providing baseline metrics to compare with outcomes after improvements. Data sources were stratified into primary sources, including stakeholders directly involved in reporting such as field teams, administrative staff, supervisors, and management; secondary sources, such as company documentation including SOPs, previous reports, organizational charts, and communication records; and process documentation from real-time observations, including timestamps, error logs, communication exchanges, and revision histories.

The study focused on three key research parameters following Lean Management and VSM principles: data accuracy, measured by reliability of numerical data verified against source documents, completeness of required information, consistency across reports, and error rates; timeliness, evaluated by total cycle time from data collection to report approval, processing and waiting times, and schedule compliance; and report format consistency, assessed through standardization, structural uniformity, information organization, and stakeholder feedback.

To ensure data accuracy and reliability, triangulation was applied: method triangulation cross-validated interviews, observations, and document analysis; source triangulation verified data across multiple stakeholder groups to reduce bias; and temporal triangulation collected data across multiple project cycles to identify patterns versus anomalies. Inter-rater reliability was confirmed by two independent researchers coding a subset of data, achieving a Cohen's kappa of 0.87, indicating strong agreement.

Data analysis employed Value Stream Mapping, adapted for administrative processes as outlined by Lasa. The process involved current state mapping to visualize all reporting steps and categorize times as value-added, necessary non-value-added, or waste; identification of Lean's seven wastes within the process and quantification of their impacts; root cause analysis using the "5 Whys" and fishbone diagrams to uncover systemic issues like lack of templates, manual entries, unclear approvals, and communication gaps; future state design incorporating digital tools such as centralized cloud platforms, automated validation, standardized templates, and automated workflows, validated via stakeholder workshops; and performance measurement comparing baseline and projected metrics on cycle times, efficiency, waste reduction, accuracy improvements, and cost-benefit of digitalization.

Quantitative data were processed using Microsoft Excel for descriptive and metric calculations, while qualitative data underwent thematic coding per Braun and Clarke's (2006) framework to identify patterns and insights for process improvement. Ethical considerations included informed consent, voluntary participation, confidentiality with anonymized data, and management approval to ensure alignment with company policies and minimize operational disruptions.

RESULTS AND DISCUSSION

Contents of Results and Discussion

VSM analysis shows that the manual reporting process takes 10.8 days with an efficiency of 44.1%, indicating significant wastes such as waiting time and data revisions. The proposed digital solution, using a centralized platform with automation, reduces the cycle time to 5.25 days and increases efficiency to 90.5%. Data accuracy is also improved thanks to automatic validation and standardized formats.

Table 1: Comparison of Current Conditions and Digitalization

Metric	Current Conditions	Digitization	Change
Cycle Time	10.8 days	5.25 days	-51,3%
Process Efficiency	44,1%	90,5%	+46,4%
Data Accuracy	Low	Tall	Increase

Contents of the Discussion Results

Overall, Table 1 illustrates that digitalization has fundamentally transformed operational workflows to achieve faster processing, enhanced efficiency, and improved reliability. The substantial reduction in cycle time (51.3%) demonstrates the effectiveness of eliminating manual handoffs and redundant approval stages, consistent with Rahani and Al-Ashraf's findings on VSM applications in process optimization. The dramatic increase in process efficiency from 44.1% to 90.5% indicates that the proportion of value-added activities nearly doubled, aligning with Lean Management principles of waste elimination articulated by Womack and Jones. Enhanced data accuracy, achieved through automated validation and standardized templates, addresses a critical challenge identified by Wang and Strong regarding data quality in organizational information systems. However, the implementation involves high initial operational costs related to software licensing, infrastructure development, and staff training, presenting a challenge that requires strategic cost management to ensure long-term sustainability and return on investment. This finding corroborates research by Dako et al. (2018) on VSM implementation in healthcare, which similarly identified initial investment barriers despite demonstrated long-term benefits.

The transformation can be understood through Freeman and McVea's stakeholder theory, which emphasizes the importance of meeting diverse stakeholder needs through efficient information systems. The improved reporting process serves multiple stakeholders: field teams benefit from simplified data entry, supervisors gain better oversight through real-time dashboards, management receives timely information for decision-making, and external partners experience more transparent communication. This multi-stakeholder value creation validates Kaplan and Norton's Balanced Scorecard perspective, which advocates for process improvements that simultaneously address operational efficiency, stakeholder satisfaction, and organizational learning.

To measure long-term sustainability, several key performance indicators have been established based on previously analyzed metrics and supported by Imai's Kaizen philosophy of continuous improvement:

1. Cycle Time Monitoring: Track whether the average reporting duration remains efficient at 5.25 days or achieves further reduction through ongoing digital system optimization. Schwaber and Sutherland's (2020) Agile metrics framework suggests continuous monitoring of cycle time as a leading indicator of process health. Quarterly assessments will identify trends and trigger corrective actions if cycle time exceeds the 5.5-day threshold.
2. Process Efficiency Maintenance: Ensure the percentage of value-added activities remains above 90%, providing evidence that the process continues to be lean and productive. This metric directly reflects the effectiveness of waste elimination efforts and prevents gradual process degradation, a concern highlighted by Lasa in their evaluation of VSM sustainability.
3. Waste Minimization: Maintain waste levels in the "Low" category by preventing the reemergence of inefficiencies such as approval delays, data errors, or redundant processing. Regular process audits using VSM methodology will identify emerging waste patterns before they become systemic problems, following the approach advocated by Rother and Shook.
4. Data Accuracy Assurance: Ensure data accuracy remains "High" through automated validation rules and regular quality checks, guaranteeing that reported information maintains its integrity. Monthly data quality reports will track error rates, revision frequencies, and validation failures, establishing a baseline for continuous improvement initiatives.
5. Operational Cost Optimization: Although currently "High" due to initial digitalization investment, ongoing cost monitoring aims to identify reduction opportunities over time through efficient resource utilization, economy of scale, and technology optimization. Cost-benefit analysis will be conducted semi-annually to track return on investment and justify continued digital infrastructure investments, as recommended by Seth and Gupta in their study of lean implementation economics.

Beyond these quantitative indicators, qualitative measures are equally critical for comprehensive sustainability assessment. Stakeholder satisfaction surveys will be administered quarterly to partners, project teams, and management to gauge user experience, identify pain points, and capture improvement suggestions. System adaptability metrics will evaluate the platform's flexibility in accommodating technological changes, regulatory updates, and evolving business requirements, ensuring the solution remains relevant in a dynamic operational environment, consistent with Turner's project management adaptability principles.

To effectively oversee the implementation and sustained operation of the digitalized reporting system, comprehensive control mechanisms are essential, drawing from 'ilma Insyifani et al.'s (2023) research on project management maturity frameworks:

1. Proactive and Reactive Control

Proactive and reactive control mechanisms form the foundation for maintaining system effectiveness. Proactive control, based on prevention principles articulated by Goldratt in the

Theory of Constraints, includes standardizing weekly reporting SOPs with detailed guidelines specifying data collection procedures, template utilization requirements, and submission deadlines. Monthly compliance audits, following Sasongko and Syairuddin's (2018) framework for project management office effectiveness, systematically monitor adherence to established protocols and detect potential issues before they escalate into operational problems. These audits employ checklists derived from the VSM analysis to ensure comprehensive coverage of all critical process elements.

Reactive control mechanisms provide rapid response capabilities when deviations occur. Real-time monitoring via digital dashboards displays key performance indicators including report submission status, data validation results, and cycle time progress, enabling immediate identification of anomalies. An automated escalation system triggers notifications when reports are delayed for two days, alerting supervisors and project managers to intervene. Root cause analysis protocols, adapted from Aka et al.'s (2017) work on waste mapping in design processes, are activated for repeated irregularities to identify systemic issues requiring corrective action. Monthly feedback sessions create structured forums for continuous improvement, allowing stakeholders to share experiences, propose enhancements, and collectively problem-solve recurring challenges, embodying the collaborative improvement culture advocated by Imai.

2. Technology Integration and Effectiveness Measurement

Technology infrastructure provides the operational backbone for control systems. The centralized Google Workspace platform enables automated activity tracking, version control, and real-time collaboration, ensuring all stakeholders work with current information and standard reporting formats. This integration addresses the coordination challenges identified by Simamora et al. (2023) in infrastructure project waste identification. Data analytics capabilities embedded in the system identify patterns of deviations, such as recurring errors from specific data sources or consistent delays at approval stages, enabling targeted interventions rather than broad corrective measures.

Early warning systems leverage artificial intelligence algorithms to provide proactive notifications for incomplete data submissions, incorrectly formatted reports, or validation failures, allowing immediate correction before reports progress further in the workflow. This predictive capability, inspired by Schwaber and Sutherland's (2020) Agile health metrics, prevents minor issues from compounding into major delays.

System effectiveness is rigorously measured through four key performance indicators: 95% on-time submission rate demonstrating strong schedule compliance; 98% data accuracy with minimal revisions indicating high information quality; 100% template compliance ensuring standardization; and deviation resolution within 24 hours showing responsive problem-solving. These metrics are tracked through automated dashboards and reviewed weekly by the project management team, with trend analysis conducted monthly to identify improvement opportunities or emerging risks.

3. Strengthening Collaboration and Communication

Robust collaboration and communication between PT Borneo Bara and partner organizations are essential for sustained system success, reflecting Freeman and McVea's stakeholder engagement principles. Weekly coordination meetings provide structured forums to discuss reporting progress, address barriers, share lessons learned, and align on priorities. These sessions follow standardized agendas to ensure consistency and comprehensive coverage of relevant topics, following Kaplan and Norton's strategic management communication frameworks.

Digital collaboration forums hosted on the centralized platform enable asynchronous communication, allowing stakeholders to share best practices, troubleshoot common issues, and access training resources at their convenience. This knowledge-sharing mechanism accelerates learning across the partner network and reduces dependency on formal training sessions.

Recognition programs acknowledge partners who consistently demonstrate excellence in accurate and timely reporting, fostering a culture of quality and accountability. Quarterly awards recognize top performers, with public acknowledgment during coordination meetings and digital forums, creating positive reinforcement that motivates continued high performance across the partner network, consistent with Imai's emphasis on recognition in continuous improvement cultures.

These integrated control, technology, and collaboration strategies ensure the digitalized reporting system operates effectively, delivers sustained value, and supports optimal cooperation among all stakeholders, positioning PT Borneo Bara for long-term operational excellence in project performance reporting.

CONCLUSION

This study examined project performance reporting challenges at PT Borneo Bara, a coal mining company in South Kalimantan, where inefficient manual processes caused delays, data inaccuracies, and inconsistent report formats that hindered operations and decision-making. Applying Value Stream Mapping (VSM) along with frameworks like the Theory of Constraints and Balanced Scorecard, the research involved interviews and multi-level data validation with stakeholders to analyze the reporting workflow. Findings revealed that the manual process had a cycle time of 10.8 days and an efficiency of 44.1%, while a proposed digital solution reduced cycle time to 5.25 days, improved efficiency to 90.5%, and elevated data accuracy from low to high through a standardized reporting format, although increased operational costs remain a concern. The study recommends routine monitoring of key performance indicators and cost optimization strategies to ensure sustainable implementation and suggests future research to explore advanced technologies and digital innovations tailored to the mining industry's unique operational environment.

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