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Performance Evaluation of a Web-Based E-Procurement System Using the PIECES Framework

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***Abstract*—Electronic procurement (e-procurement) plays an important role in improving transparency, efficiency, and accountability in organizational procurement processes, particularly in higher education institutions. However, many e-procurement systems are implemented without systematic performance evaluation, which may result in unresolved operational inefficiencies, information quality issues, and weak control mechanisms. This study aims to evaluate the performance of a web-based e-procurement system implemented at Universitas Wijaya Kusuma Surabaya using the PIECES framework, which examines six dimensions: Performance, Information, Economics, Control, Efficiency, and Service.**

This study adopts a descriptive–evaluative research design supported by system observation, functional testing, and analysis of procurement workflows and system artifacts. The PIECES framework is applied to assess system throughput and response time, information accuracy and accessibility, economic efficiency, control and security mechanisms, resource utilization efficiency, and service quality for key stakeholders, including administrators, procurement officers, and vendors.

The results show that the e-procurement system improves procurement process performance by reducing processing time and standardizing workflows. Centralized data management enhances information accuracy, traceability, and accessibility. Operational costs are reduced through minimized paper-based procedures and administrative activities, while role-based access control and audit trails strengthen governance and accountability. In addition, improved system usability enhances service quality for all stakeholders.

Overall, this study confirms that the PIECES framework is effective for evaluating institutional e-procurement systems and provides practical insights for higher education institutions seeking to improve procurement performance and governance through digital systems.

Keywords—E-procurement; PIECES framework; information systems evaluation; system performance; higher education

I. INTRODUCTION

Procurement of goods and services constitutes a critical operational function in higher education institutions, as it directly supports academic delivery, research activities, and administrative continuity. Universities routinely manage procurement activities involving learning infrastructure, information technology, laboratory equipment, and institutional services. Consequently, procurement systems are expected to operate efficiently, transparently, and accountably in order to ensure effective resource utilization and institutional governance. However, in many higher education institutions, procurement processes are still conducted using manual or semi-manual procedures, which often lead to fragmented documentation, prolonged verification cycles, limited traceability, and inconsistent standard operating procedures [1].

Manual procurement practices pose significant challenges, particularly in institutions with complex organizational structures and multiple procurement stakeholders. Repeated submission of bidding documents, lack of centralized data storage, and dependence on paper-based workflows increase administrative workload and slow down decision-making processes. These limitations not only reduce operational efficiency but also weaken transparency and accountability, which are essential principles in institutional governance [2]. Previous studies have highlighted that such conditions may increase the risk of data inconsistency, reduce audit readiness, and hinder effective monitoring of procurement performance [3].

To address these challenges, electronic procurement (e-procurement) systems have been widely adopted across public and institutional sectors. E-procurement refers to the use of information and communication technology to support end-to-end procurement activities, including requisition submission, vendor registration, bid evaluation, and contract management through web-based platforms [4]. Prior research demonstrates that e-procurement systems can significantly reduce administrative costs, shorten procurement cycle times, and improve information accessibility for decision makers [5]. In higher education contexts, the adoption of e-procurement is increasingly viewed as a strategic initiative to support digital transformation and strengthen institutional governance.

espite the recognized benefits of e-procurement adoption, system implementation alone does not guarantee improved performance. Several studies report that many organizations focus predominantly on system development and deployment, while systematic evaluation of system performance is often overlooked [6]. Without structured evaluation, institutions may fail to identify performance bottlenecks, information quality issues, cost inefficiencies, or weaknesses in control mechanisms that could undermine the effectiveness of the system. Therefore, a comprehensive evaluation framework is required to assess whether an e-procurement system effectively meets organizational objectives and stakeholder needs.

One widely used framework for information system evaluation is the PIECES framework, which analyzes systems across six dimensions: Performance, Information, Economics, Control, Efficiency, and Service. The PIECES framework enables evaluators to identify technical, managerial, and service-related issues in a structured and holistic manner [7]. Previous studies have successfully applied PIECES to evaluate institutional information systems, demonstrating its effectiveness in identifying system strengths, weaknesses, and improvement priorities [8]. However, empirical studies applying the PIECES framework specifically to e-procurement systems in higher education institutions remain limited.

In response to this gap, this study evaluates the performance of a web-based e-procurement system implemented at Universitas Wijaya Kusuma Surabaya using the PIECES framework. The evaluation focuses on how the system addresses operational challenges associated with manual procurement practices and how it contributes to improved efficiency, transparency, and governance. By providing a comprehensive performance assessment, this study aims to offer empirical evidence and practical insights for higher education institutions seeking to optimize procurement operations through digital systems.

II. Literature Review

A. Information Systems Planning and Organizational Performance

Information systems play a strategic role in supporting organizational performance, particularly in institutions that operate complex administrative and operational processes. Strategic information systems planning enables organizations to align information technology initiatives with business objectives and institutional governance requirements. Several studies emphasize that effective information systems planning contributes to improved efficiency, coordination, and competitive advantage, especially in higher education institutions [4], [11], [12].

In the context of universities, information systems are not merely operational tools but strategic assets that support academic services, administrative processes, and institutional decision-making. Prior research highlights that the absence of structured information systems planning may result in fragmented applications, redundant processes, and limited performance measurement capabilities [16], [17]. Therefore, the development and evaluation of institutional information systems must be grounded in a strategic perspective that considers organizational goals and performance outcomes. Business process–oriented analysis is essential to ensure that information systems implemented in higher education institutions are aligned with institutional needs and operational priorities, particularly for supporting administrative and procurement-related functions [19]. Strategic information systems planning plays a critical role in ensuring that institutional systems deliver operational value and support governance objectives, particularly in higher education environments [20].

B. Digital Systems and Service Quality in Institutional Processes

Service quality is a critical dimension in evaluating institutional information systems, particularly those that involve multi-stakeholder interactions. Studies focusing on online and digital services indicate that system usability, accessibility, and reliability significantly influence service quality and user satisfaction [13], [15]. In public and institutional environments, digital systems are expected to enhance transparency, responsiveness, and accountability, while reducing administrative burdens.

Research on online service implementation in government and institutional settings shows that digital platforms can improve service delivery by standardizing procedures and enabling faster information access [19]. However, these benefits can only be realized when systems are properly evaluated and aligned with organizational workflows. Inadequate evaluation may lead to underutilization of system features and persistence of manual practices, thereby limiting performance improvements.

C. Strategic Analysis and Evaluation Frameworks in Information Systems

Various analytical frameworks have been employed to evaluate organizational performance and information systems effectiveness. SWOT analysis has been widely used to assess internal and external factors influencing organizational strategy and system development [1], [5], [7], [9]. In higher education institutions, SWOT-based evaluations have been applied to analyze strategic readiness and identify improvement priorities in digital initiatives [18].

In addition to SWOT, strategic information systems planning frameworks such as Ward and Peppard emphasize the importance of aligning information systems with business strategy and organizational capabilities [11], [12], [14]. These frameworks highlight the need for systematic evaluation to ensure that information systems deliver value and support institutional objectives. Although these approaches provide valuable strategic insights, they often focus on planning and alignment rather than operational performance evaluation.

D. Performance Measurement and the Need for Comprehensive Evaluation

Performance measurement frameworks such as the Balanced Scorecard have been applied to evaluate organizational and information systems performance by integrating financial and non-financial indicators [13], [15]. These approaches underline the importance of assessing system performance from multiple perspectives, including efficiency, service quality, and organizational impact. In institutional environments, comprehensive evaluation is essential to ensure that information systems effectively support governance and operational processes.

Despite the availability of various strategic and performance-oriented frameworks, there remains a need for evaluation approaches that explicitly address operational system performance and service effectiveness in integrated digital systems. This is particularly relevant for procurement-related information systems, which involve critical administrative functions and require high levels of transparency and control.

E. Research Gap and Positioning of the Study

Based on the reviewed literature, it is evident that prior studies have extensively discussed strategic information systems planning, service quality, and organizational performance evaluation in institutional contexts [4], [11], [13], [18]. However, empirical research that focuses on comprehensive performance evaluation of institutional digital systems—particularly procurement-related systems—remains limited. Existing studies tend to emphasize strategic analysis and planning rather than systematic assessment of system performance across operational dimensions.

Accordingly, this study positions itself by applying a comprehensive evaluation framework to assess the performance of a web-based e-procurement system in a higher education institution. By grounding the analysis in established information systems and performance evaluation literature, this research contributes empirical insights into how digital procurement systems support efficiency, service quality, and governance in university environments.

III. Materials and Methods

A. Research Design

This study employed a descriptive–evaluative research design to assess the performance of a web-based e-procurement system implemented at Universitas Wijaya Kusuma Surabaya. The research focused on evaluating system performance after implementation rather than on system development activities. The evaluation approach was selected to systematically identify improvements achieved through system adoption and to assess how the system supports institutional procurement processes in practice. The evaluation perspective adopted in this study is consistent with business process identification approaches commonly applied in higher education information systems planning [19].

B. Research Object and Scope

The object of this research was the institutional e-procurement system developed to support procurement activities at Universitas Wijaya Kusuma Surabaya. The system accommodates procurement workflows involving multiple stakeholders, including administrators, LPSE officers, and registered vendors. The evaluation scope covered the end-to-end procurement process, including procurement request submission, vendor registration, tender management, bid submission, evaluation, negotiation, and determination of procurement winners, as implemented within the system.

C. Data Collection Techniques

Data were collected using multiple techniques to ensure comprehensive evaluation.

(1). System observation was conducted to examine system workflows, user interactions, and functional modules within the e-procurement platform.

(2) Document analysis was performed on procurement records, system logs, and system documentation generated during system operation.

(3) Functional testing results obtained during system trials were analyzed to verify that system features operated according to predefined functional requirements. These data collection techniques enabled evaluation of system performance from both operational and managerial perspectives.

D. Evaluation Framework (PIECES)

System evaluation was conducted using the PIECES framework, which analyzes information systems across six dimensions: Performance, Information, Economics, Control, Efficiency, and Service. The framework was selected because it provides a structured and holistic approach for identifying system strengths, weaknesses, and improvement priorities across technical, organizational, and service dimensions.

Performance evaluation focused on transaction throughput and system response time during procurement activities. **Information** evaluation examined the accuracy, completeness, accessibility, and relevance of procurement information produced by the system. **Economics** evaluation assessed cost efficiency related to system adoption, including reductions in administrative and operational costs. **Control** evaluation analyzed access authorization, data security mechanisms, and audit trail availability. **Efficiency** evaluation examined optimal utilization of system resources and reduction of redundant manual processes. Service evaluation focused on system usability, accessibility, and quality of service experienced by system users.

E. Data Analysis Procedure

Data analysis was conducted by mapping observed system characteristics and empirical findings to each PIECES dimension. The analysis was performed descriptively by comparing procurement conditions before and after system implementation. Each PIECES dimension was evaluated independently, followed by an integrated interpretation to assess overall system performance. This procedure enabled systematic identification of operational improvements, governance enhancements, and remaining challenges in the implementation of the institutional e-procurement system.

IV. Result and Discussion

The results of the e-procurement system evaluation are presented and discussed by aligning empirical observations with the evaluation indicators defined in the PIECES framework. This approach ensures consistency between the evaluation methodology and the interpretation of findings, while enabling a comprehensive assessment of system performance within the institutional procurement context. The discussion focuses on how the implemented system addresses operational challenges associated with manual procurement practices and supports efficiency, transparency, and governance.

To provide a concise and integrated overview of the evaluation outcomes, the key findings across all PIECES dimensions are summarized in Table 1. The table synthesizes the evaluation aspects, principal results, and their interpretations, and serves as a reference point for the detailed discussion in Subsections A–F, where each PIECES dimension is elaborated in greater depth.

A. Performance

As summarized in Table 1, the evaluation results indicate that the e-procurement system improves transaction throughput and response time compared to manual procurement procedures. Automated workflows enable faster processing of procurement requests, bid submissions, and document verification, thereby reducing operational delays. These findings demonstrate that the system effectively supports institutional procurement workloads and meets the performance criteria defined in the evaluation framework.

B. Information

Referring to the Information dimension in Table 1, the system shows significant improvement in data accuracy, completeness, and accessibility. Centralized storage of procurement documents ensures consistent version control and traceability throughout the procurement lifecycle. This condition supports timely access to reliable information for authorized users and enhances managerial decision-making within the institution.

C. Economics

The Economics results presented in Table 1 indicate that the e-procurement system contributes to improved cost efficiency. Although initial investment is required for system development and deployment, operational costs are reduced through decreased paper usage and minimized manual administrative activities. These findings suggest that the system delivers long-term economic benefits that justify its implementation.

D. Control

s shown in Table 1, the Control dimension highlights improvements in governance and security through role-based access control and audit trail mechanisms. Restricting system access according to user roles enhances accountability and reduces the risk of unauthorized data manipulation. The availability of digital logs further supports monitoring and audit processes, strengthening institutional control.

E. Efficiency

The Efficiency dimension summarized in Table 1 demonstrates that the e-procurement system optimizes resource utilization by integrating multiple procurement activities within a single platform. The reduction of redundant data entry and manual verification processes leads to more streamlined workflows and improved operational efficiency across procurement stages.

F. Service

In terms of Service, the findings in Table 1 show that system usability and accessibility are improved for all stakeholder groups. Administrators benefit from centralized monitoring features, procurement officers experience simplified transaction handling, and vendors gain easier access to tender information and document submission facilities. These improvements collectively enhance service quality and stakeholder interaction.

Overall, the results presented in Table 1 and discussed in Subsections A–F confirm that the e-procurement system delivers comprehensive performance improvements across all PIECES dimensions. The alignment between evaluation criteria and empirical findings demonstrates the suitability of the PIECES framework for assessing institutional e-procurement systems in higher education environments. By addressing performance, information quality, economic efficiency, control mechanisms, operational efficiency, and service quality simultaneously, the system supports both operational effectiveness and institutional governance.

To provide a concise and integrated overview of the evaluation outcomes, the key findings across all PIECES dimensions are summarized in Table 1. The table synthesizes the evaluation aspects, principal results, and their interpretations, serving as a reference point for the subsequent detailed discussion of each dimension. This presentation allows readers to easily trace the relationship between evaluation criteria and observed system performance.

Table 1. The key findings and interpretation of each dimension

PIECES Dimension	Evaluation Aspect	Key Findings	Interpretation
Performance	Transaction throughput and response time	Procurement request processing, document submission, and bid evaluation are completed faster compared to manual procedures	System improves operational speed and supports institutional procurement workload
Information	Accuracy, completeness, and accessibility of data	Procurement documents and transaction records are stored in a centralized database with consistent version control	Information quality and traceability are significantly improved
Economics	Operational cost efficiency	Reduction in paper usage, duplicated administrative tasks, and manual processing effort	System contributes to long-term cost efficiency despite initial implementation cost
Control	Access control and auditability	Role-based access control and digital audit trails are implemented for procurement activities	Governance, accountability, and data security are strengthened
Efficiency	Resource utilization and workflow integration	Integrated platform reduces redundant data entry and manual verification	Procurement workflows become more streamlined and resource-efficient
Service	Usability and stakeholder accessibility	Administrators, procurement officers, and vendors can access system features according to their roles	Service quality and user interaction experience are improved

V. CONCLUSION

This study evaluated the performance of a web-based e-procurement system implemented at Universitas Wijaya Kusuma Surabaya using the PIECES framework. The findings demonstrate that the system delivers measurable improvements across all evaluated dimensions. From a performance perspective, procurement processes benefit from faster response times and improved transaction throughput. Information quality is enhanced through centralized data management, which supports traceability and consistency throughout the procurement lifecycle.

Economic analysis indicates that although system implementation requires initial investment, operational efficiency and reduced administrative overhead contribute to long-term cost benefits. Stronger control mechanisms, including role-based access and audit trails, improve governance and reduce risks related to unauthorized access or data manipulation. In addition, efficiency gains are achieved by minimizing redundant manual activities, while service quality improves through better accessibility and usability for administrators, procurement officers, and vendors.

Overall, this study confirms that the PIECES framework is effective for evaluating institutional e-procurement systems and identifying improvement priorities. The results provide practical guidance for higher education institutions seeking to modernize procurement operations and strengthen governance. Future research may extend this work by incorporating quantitative performance metrics, user satisfaction surveys, or comparative studies across multiple institutions

AUTHOR CONTRIBUTIONS

E.W. conceptualized the study, supervised the research process, and coordinated the overall research activities. A.K.A. contributed to system analysis and evaluation design, particularly in defining the performance assessment framework. F.X.W.Y.U. participated in data analysis, system validation, and interpretation of evaluation results. Y.P.I. was responsible for system development, data collection, and implementation testing. All authors contributed to manuscript preparation, critically reviewed the content, and approved the final version of the manuscript.

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