

Enhancing Transparency in Public Procurement: Development of a Web Application for Evaluating Peruvian Suppliers

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ABSTRACT

This study presents the design and implementation of a web application to evaluate suppliers' knowledge in public procurement processes in Peru, addressing the growing need for transparency and efficiency. The platform features a modular web architecture, an intuitive assessment interface, an AI-powered question generator and performance evaluation tool, and automated assessment reports aligned with the national regulatory framework and hiring categories. The main contribution of this work lies in the development of an automated and scalable approach to objectively assess regulatory knowledge, going beyond traditional procurement platforms that focus primarily on access to information and procurement search systems. A preliminary pilot test conducted in three private companies demonstrated a 55% reduction in evaluation time compared to manual processes, a latency p95 between 480–620 ms, and a 0% error rate under concurrent usage conditions. User satisfaction was 4.3 out of 5 on the Likert scale, demonstrating the usability and effectiveness of the platform. The reported results correspond to a preliminary pilot, with a larger validation involving 10 organizations and more than 120 participants across eight Peruvian regions planned for future work. Further research will expand the assessment through scenario-based evaluations, fairness-aligned criteria, and comparative analysis with existing tools using cost–benefit and ROI metrics.

Keywords-public procurement; web application; suppliers evaluation; artificial intelligence; digital government

I. INTRODUCTION

Public procurement is a key element in the economic and social development of Peru. In 2022, public investment execution reached S/46.592 billion (about \$13.7 billion), while contracts for goods, services, and works also represented a significant share of government expenditure under the Government Procurement Law [1]. Despite this scale, several institutional reports highlight a persistent lack of technical preparation among applicants and suppliers. Formal errors, disqualifications, and abandoned procedures reduce procurement efficiency and affect the effective allocation of public resources. This situation particularly limits the participation of SMEs from regions with fewer training opportunities and reduces market competition [2].

The absence of objective evaluation tools and immediate feedback discourages new suppliers and weakens the professionalization of the supplier ecosystem. Although platforms such as the State Electronic Procurement System (SEACE) and the OSCE Virtual Classroom exist, as well as private opportunity-search tools like LiciApp, these systems do not automatically assess users' knowledge of procurement regulations. This limitation reveals a research gap in the development of tools that support competency-based assessment in public procurement environments.

To address this gap, the present study proposes a customized web application designed to evaluate applicants' competencies in Peruvian public procurement based on Law No. 32069 – General Law on Public Procurement [3]. The system integrates automated regulatory tests, performance reports, and immediate feedback, aiming to reduce formal mistakes, support better selection of procurement specialists, and improve SME participation.

II. RELATED WORKS

Existing research has highlighted the importance of efficiency in public procurement processes, particularly through the use of structured award criteria [4]. Organizational capabilities and evaluation approaches play a significant role in improving procurement performance and outcomes [5, 6]. In addition, economic analyses of e-procurement initiatives suggest that digital systems can support more efficient resource allocation and enhance overall procurement effectiveness [7, 8]. Beyond efficiency, public procurement has been associated with broader objectives such as sustainability, transparency, and social value. Procurement practices aligned with policy goals and sustainability principles can contribute to improved operational performance and more equitable outcomes in public services [9-11]. These findings reinforce the role of procurement as a strategic instrument for public value generation rather than merely an administrative process.

The digital transformation of procurement systems has strengthened transparency and efficiency, with e-procurement platforms linked to improved traceability, institutional performance, and decision-making [12]. A user-centered e-government service design framework has also been proposed to show how usability and citizen experience directly influence public trust in sustainable policies, extending the

discussion beyond technical efficiency to institutional legitimacy [13]. Additionally, factors such as web accessibility and system performance have been identified as significant elements influencing usability and user trust in digital public platforms [14, 15].

From a user-centered perspective, the importance of usability, system integration, and user satisfaction in the adoption of digital services has been emphasized. Evidence suggests that user experience, supplier interaction, and system design play a key role in improving engagement in e-government environments [16, 17]. Citizen-centered service design has been identified as essential to ensure that digital platforms effectively address user needs and improve service adoption [18]. Furthermore, learning analytics approaches highlight the relevance of automated indicators for objectively evaluating user performance in digital platforms, reinforcing the importance of data-driven evaluation methods in systems that assess user competencies [19]. Adaptive e-learning approaches based on artificial intelligence have been proposed to personalize evaluation processes and learning paths according to user performance, highlighting the potential of intelligent systems in competency-based assessment environments.

Despite these advances, existing literature shows limited focus on tools specifically designed to assess the regulatory knowledge of suppliers in public procurement contexts. Most current platforms prioritize information access, transaction management, or opportunity identification, rather than competency evaluation.

Although prior studies highlight the importance of efficiency, digital transformation, and user-centered design in public procurement systems, most existing approaches remain focused on improving process transparency, information accessibility, or transaction management, with limited emphasis on the objective and automated evaluation of suppliers' regulatory knowledge. While some works explore performance metrics and user experience in digital platforms, they rarely address competency-based assessment supported by integrated evaluation mechanisms, limiting their capacity to enable data-driven decision-making and to objectively assess supplier preparedness.

In this context, the proposed approach offers a comprehensive platform for the objective assessment of supplier competencies, integrating structured knowledge assessments, AI-driven question generation, and performance analysis, as well as mechanisms for immediate feedback. The main contribution lies in enabling a scalable, data-driven evaluation process. This places the present study at the intersection of e-procurement and intelligent evaluation systems, contributing to the advancement of competency-based evaluation on digital government platforms.

III. SYSTEM DESIGN

A. Embedded Architecture

EVACOP is an online tool to evaluate knowledge related to public procurement that enables evaluators to build tests, manage tailored question banks, auto-generate evaluations, and

analyze performance using artificial intelligence. The architecture of the embedded framework is illustrated in Figure 1. The system comprises a client interface, application services including session control and rule management, and storage for periodically backed-up data for incident recovery.

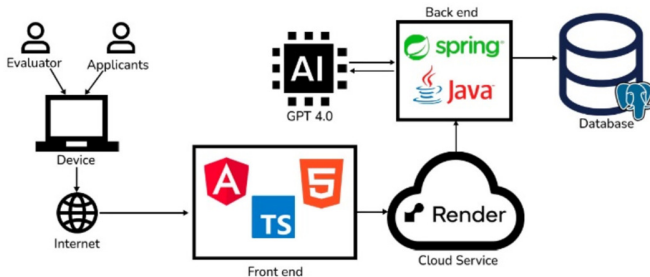


Fig. 1. Architecture of the embedded framework.

Evaluators connect with applicants, from their devices, over the Internet, with a web front end (Angular/TypeScript/HTML5), which is deployed in the Render cloud. The front end then loads the interface in the browser. Also, for each task (authentication, creation/editing of questions, submission of evaluations, consultation of reports), it calls REST APIs over HTTPS to the backend. Back end (Java/Spring, also in Render) focuses on business logic and security (JWT and role-based access control) and has dedicated services such as question bank management, evaluation assembly, AI-assisted item generation, feedback (integration with GPT-4.0), and analytics (metric calculation and indicators for topic and cohort). Finally, back-end calls PostgreSQL to store users, questions, item versions, evaluations, attempts, and results. It also provides automatic backups and restoration policies for continuity and data protection.

B. Methodology

This study follows a design and evaluation approach aimed at developing and validating a web-based system for competency assessment in public procurement. The methodology combines system development with empirical evaluation through pilot testing, focusing on performance metrics, user interaction, and system reliability. This approach enables the assessment of both the technical functionality and the practical applicability of the proposed solution in real-world environments.

1) Dataset Collection

The dataset construction, preprocessing procedures, and evaluation metrics are explicitly defined to facilitate reproducibility. The described processes follow structured and documented steps that can be replicated in similar procurement environments. The application allows custom question banks and automatically generates evaluations utilizing a proprietary bank of 130 questions, serving as the standard measure of public procurement knowledge in Peru. It consists of 30 general knowledge items based on General Public Procurement Law No. 32069 [3] and 100 sector-specific items distributed across five categories with 20 questions each: health, Information Technology (IT), machinery and vehicles, construction materials, and office and furniture equipment.

Every item includes a statement, multiple-choice responses, an answer key (True/False) or open-ended response, and a percentage score. To abide by the pre-set criteria of eligibility, a bank was chosen; this aligns it closely with current Peruvian regulations, ensures a balanced allocation by sectors, and is accompanied by instructional metadata.

This choice also allows for the maintenance and controlled updating of regulatory requirements across different sectors, quality control, and licensing clarity. However, validation is conducted using function tests with users from private companies that either hire or participate in selection procedures with the State (grouped by sector). Sensitive or biometric personal information is not provided, and all interactions and aggregated results are documented. Sensitive or biometric personal information is not collected, and all data are anonymized and analyzed in aggregated form. Based on these conditions, formal ethics committee approval was not required; however, any institutional requirements will be addressed before deployment.

The dataset is divided by question and category using a stratified approach by sector: 70% is used for system configuration and calibration of selection logic, 20% for validation of thematic consistency and scoring structure, and 10% for testing system performance under real-world conditions, for example, timing, score computation, and report generation under real-world usage. Current division preserves the 30/100 (general/sectoral) percentage in each subset to prevent data breach between partitions. As a proprietary and local-domain-oriented bank, no public subsets were used. The approach is justified by the need to include current legislation to cover the specific nuances of each sector in the context of Peru.

2) Dataset Preprocessing

Before analysis, the question content and usage records were cleaned and standardized. This included normalizing text, removing unnecessary characters, verifying required fields (statement, answers, category, difficulty, and score), and merging category and level catalogs. Quality control procedures were applied to remove duplicates and inconsistencies, while minimal metadata (topic, item type, and estimated time) were added to support reporting and test assembly. Operational data were processed under a privacy approach, anonymizing identifiers and analyzing only aggregated information. Dataset partitions were created per user and session to prevent information leakage during pilot assessments. The preprocessing workflow is illustrated in Figure 2.

3) System Development

The system follows a deterministic engine in the automatic correction of True/False and multiple-choice questions. In contrast, open-ended responses are subject to evaluator verification when applicable. The evaluation generator is a rule-based assembler respecting the category of questions and avoiding items that have been categorized as ambiguous. Generative AI proposes question formulations and explanatory feedback for this process. In the current implementation, the AI component is used as a supporting mechanism for question

generation and feedback assistance rather than as a predictive or classification model. Therefore, conventional evaluation metrics such as accuracy are not directly applicable.

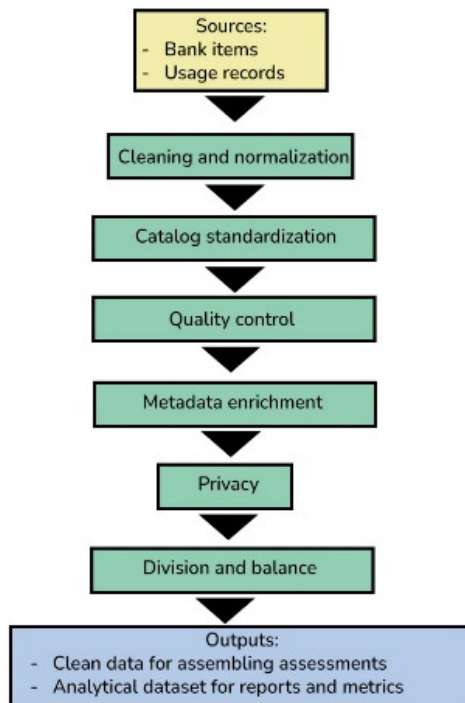


Fig. 2. Data preprocessing flow.

Simultaneously, analytic components calculate operational and quality measures (e.g., accuracy by topic, time spent, problematic questions), and develop reports for evaluators. Thresholds and rules are also calibrated (like time limits or anomalous error rates) based on internal pilot tests and real usage. Item version control and updates are maintained to regulatory changes. Figures 3 and 4 illustrate the operational

workflow of the system, showing how evaluation results and performance indicators are generated and interpreted within the proposed methodology. These functionalities are depicted in Figure 3 in the evaluator dashboard, including aggregated evaluation statistics and performance KPIs.

4) Testing

Verification focuses on a test plan intended to maintain system accuracy and stability. This plan comprises functional tests of the correction engine (to check the expected results with True/False and multiple-choice items against sample reviews of open-ended responses), assembler verification (category quota compliance and exclusion of doubtful items), and end-to-end testing across a pre-production life cycle (from item editing through report generation). Performance testing is likewise carried out at moderate concurrent load, and there are security controls related to authentication functions as well as access management. Finally, internal pilot tests are carried out in organizations engaged in the procurement process to simulate behavior under real conditions and obtain qualitative data. Any observed events are, however, recorded and rectified before the operational deployment of the system.



Fig. 3. Evaluator dashboard showing performance metrics and evaluation indicators.



Fig. 4. Evaluation result interface showing user responses and automated feedback.

TABLE I. EVALUATION METRICS

Metric	Description	Formula	Comment
Latency p95	Response time at the 95th percentile for critical operations.	$p95(TR)$	TR = Response time (ms)
Error rate	Proportion of requests that return a server error.	$\frac{R5xx}{ST}$	R5xx = 5xx responses ST = Total requests
Average completion time	Average duration to complete a published assessment.	$\frac{\sum TF}{\#IF}$	TF = Completion time IF = Finished attempts
Evaluation abandonment	Attempts started but not completed.	$\frac{II - IF}{II}$	II = Initiated attempts
Items to review	Portion of questions marked as problematic during use.	$\frac{\#IM}{\#IU}$	IM = Marked items IU = Used items
User satisfaction	Post-assessment rating provided by applicants.	$\frac{RS}{TR}$	RS = Rating scale TR = Total responses

The pilot study was designed as an exploratory validation to assess system performance and usability under real-world conditions. Although limited in scale, it provides initial empirical evidence to support the feasibility and effectiveness of the proposed approach.

5) Performance Evaluation Metrics

Evaluation is conducted on platform performance and the quality of the applied tests. Hence, operational and usage metrics represent corrector accuracy, the stability of the evaluation workflow, and user experience. The key metrics and formulas employed for evaluation are presented in Table I.

IV. RESULTS

For public procurement, the EVACOP platform was implemented in three private Peruvian companies, each involving one evaluator and between three and five applicants. Its efficiency was tested to verify its operation under actual operating conditions. This is a preliminary pilot study only. An extended pilot (10 organizations, 120+ participants, 8 Peruvian regions) has been formally defined for future execution to strengthen sample representation, but is not re-run now due to tight camera-ready timing; therefore, current metrics remain unchanged. Planned system benchmarking against opportunity-search and evaluation platforms will be reported in the next validation pilot and is not part of the current preserved metrics. This submission evaluates only regulatory knowledge in its current version; scenario-based practical assessment, fairness-aligned ethical criteria, and additional instrument validity dimensions are defined for future pilot stages and do not alter the present reported metrics.

In technical terms, latency p95, which is widely used in system performance evaluation to represent real-world responsiveness under typical and peak conditions, was between 480 and 620 ms, and the system remained stable even under concurrent usage. Also, there were no server errors or session interruptions recorded; thus, a 0% error rate was achieved. The average completion time for evaluation was from 30-50 min for 78% and 1-1.5 h for the remaining 22% respondents, a 55% decrease in time relative to traditional manual evaluation. There were no dropouts or problematic items, indicating that the system was stable and that the AI-supported automatic generation module was consistent.

Due to the limited sample size of the pilot study, the analysis focuses on descriptive metrics. The inclusion of statistical dispersion measures such as standard deviation is

planned for future large-scale validation. The results of the main metrics used in tests with the three collaborating companies are summarized in Table II.

TABLE II. KEY METRICS OBTAINED FROM EXPERIMENTAL VALIDATION WITH THE THREE COMPANIES

Metric	Result obtained	Interpretation
Latency p95	480–620 ms	Smooth response in a real-world environment
Error rate	0%	No server failures or interruptions
Average completion time	78% between 30–50 min, 22% between 1h–1h 30 min/1-1.5h	55% reduction compared with the manual process
Evaluation abandonment	0%	All evaluations completed
Items to review	0	Items consistent with each category

On the satisfaction survey, all items exceeded 4 out of 5 on the Likert scale, with particularly high scores for the intuitive interface (4.4), clear feedback (4.3), and system speed (4.2). Users reported strong overall acceptance, as displayed in Figure 5, emphasizing the platform's ease of interaction and visual clarity.

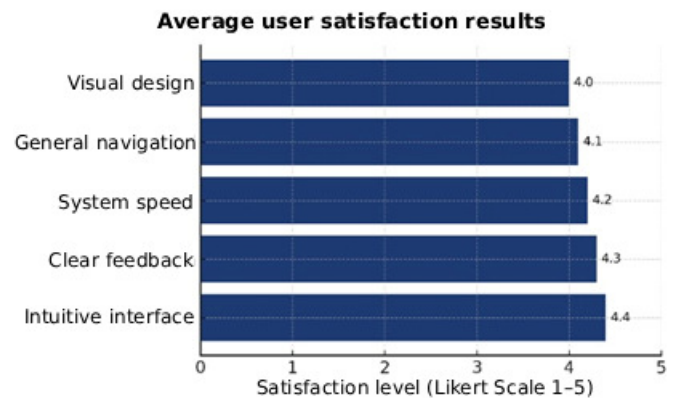


Fig. 5. Average user satisfaction score.

From a usability perspective, the results demonstrate the effectiveness of the interface design and feedback mechanisms, facilitating user interaction and improving the overall evaluation experience. These findings also suggest that the adoption of automated evaluation tools can enhance supplier

preparedness, reduce formal errors in submissions, and support more transparent and efficient public procurement processes. However, these results are based on a preliminary pilot study with a limited number of participants, and therefore should be interpreted with caution until further large-scale validation confirms their generalizability.

Overall, the results provide initial evidence that EVACOP meets key criteria in terms of accuracy, stability, and user satisfaction, supporting its potential as a viable tool for the objective evaluation of applicants in public procurement processes in Peru.

V. DISCUSSION

The findings of this study demonstrate the potential of integrating automated evaluation mechanisms within public procurement systems to enhance transparency and objectivity. Unlike existing platforms that primarily focus on information access and transaction management, the proposed approach introduces competency-based assessment as a core component, contributing to a more structured and data-driven evaluation of suppliers.

The results suggest that the adoption of automated evaluation tools can support decision-making processes by improving the technical preparedness of applicants and reducing common procedural errors. This is particularly relevant in contexts where limited training and a lack of standardized evaluation mechanisms affect participation and efficiency, such as in Peruvian public procurement. Furthermore, the study contributes to the growing intersection between e-procurement and intelligent evaluation systems, where digital platforms are not only used to manage processes but also to assess user competencies and generate actionable insights. This shift represents an important step toward more transparent, accountable, and performance-oriented procurement ecosystems.

Finally, although the findings provide initial evidence of feasibility and effectiveness, they should be interpreted within the context of a preliminary pilot study. Future research will be necessary to validate these results at a larger scale and to further explore the impact of competency-based evaluation on procurement outcomes.

VI. LIMITATIONS AND FUTURE PERSPECTIVES

The current results are derived from a small preliminary pilot involving three companies and fewer than fifteen applicants. This limited sample size restricts the statistical generalization of the findings and means that the reported outcomes should be interpreted as exploratory trends rather than definitive evidence of system effectiveness. The restricted scope may also bias the results toward the specific conditions of the participating companies, and the absence of practical or ethical competency evaluation further narrows the conclusions that can be drawn.

Although an extended pilot involving 10 organizations and more than 120 participants across eight Peruvian regions has been formally planned, its implementation was postponed due to logistical constraints such as travel costs and administrative

coordination challenges. Future work will expand the number of participants, incorporate additional performance metrics (such as correlations between test scores and actual bidding success), and conduct comparative benchmarking and ROI-based cost-benefit analyses against existing opportunity-search and evaluation platforms. These extended pilots aim to better characterize system adoption value and operational efficiency at scale, thereby addressing the current limitations and enabling more robust and generalizable conclusions.

VII. CONCLUSION

This study introduced the EVACOP platform, an effective and practical instrument for the objective evaluation of applicants in public procurement processes. The results indicate that cloud-based architecture, AI-driven item generation, and near-immediate response to users improve accuracy, speed, and satisfaction with the efficiency of the products. The platform achieved zero server errors, 55% reduction in evaluation time, and on the satisfaction survey, all items exceeded 4 out of 5 on the Likert scale, demonstrating its technical ability and user acceptance.

Overall, the proposed solution helps to increase transparency and professionalization in the public procurement system of Peru. Future work is proposed to expand the question bank, enhance interoperability with state systems, and develop analytical models to improve capacity management in the public service ecosystem.

DECLARATION OF COMPETING INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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