O&PM Brazilian Journal of Operations & Production Management

ISSN 2237-8960 (Online)

ABEPRO ASSOCIAÇÃO BRASILEIRA DE ENGENHARIA DE PRODUÇÃO

CASE STUDY

Digital management system for public works evaluation: the Brazilian e-Obras platform case study

Henrique Mendes da Rocha Lopes[1], Alberto Casado Lordsleem Júnior[1], Joaquin Humberto Aquino Rocha[2]

[1]Federal University of Pernambuco (UFPE), Recife, Brazil.
[2]Universidad Mayor de San Simón (UMSS), Cochabamba, Bolivia.

How to cite: Lopes, H. M. R; Lordsleem Júnior, A. C. and Rocha, J. H. A. (2026), "Digital management system for public works evaluation: the Brazilian e-Obras platform case study", *Brazilian Journal of Operations and Production Management*, Vol. 23, No. 2, e20263241. https://doi.org/10.14488/BJOPM.3241.2026

ABSTRACT

Goal: To develop an evaluation framework for public works management systems and apply it to assess the performance of the e-Obras platform.

Design / Methodology / Approach: The Delphi method was employed to develop the Public Works Management System Checklist (PWMSC). The checklist was subsequently applied to the e-Obras platform to evaluate its performance across key management dimensions, including cost, schedule, scope, quality, environment, and occupational health and safety.

Results: The PWMSC proved to be an effective assessment framework. The e-Obras platform demonstrated high compliance with cost (93%), schedule (86%), and scope (100%) indicators; however, it showed no compliance (0%) with quality, environmental, and occupational health and safety indicators. These results indicate strong support for the traditional project management triad, while revealing critical shortcomings in complementary performance dimensions. Opportunities for improvement include strengthening control mechanisms, standardizing contractual change justifications, and enhancing KPI visualization and monitoring capabilities.

Limitations of the investigation: The analysis was limited to a single platform, which may restrict the generalizability of the findings. Furthermore, the checklist validation was based on expert judgment obtained through the Delphi method.

Practical implications: The PWMSC provides a practical framework for evaluating and improving public works management systems, supporting decision-making and promoting the integration of quality, sustainability, and safety considerations into digital management platforms.

Originality / Value: This study proposes a novel evaluation framework that extends beyond the traditional cost–schedule–scope triad by incorporating quality, environmental, and occupational health and safety dimensions into the assessment of public works management systems.

Keywords: Public works management; Performance indicators; Construction management software.

1 INTRODUCTION

The construction industry plays an essential role in the economic and social development of countries (Guimarães, 2024), yet it continues to face persistent challenges that hinder productivity, efficiency, and sustainability (Mattos, 2019). In this context, management software has emerged as a key enabler of sector modernization, facilitating the transition toward practices aligned with Industry 4.0 principles (van der Heijden, 2023).

Financial support: none.
Conflict of interest: none.
Corresponding author: joaquinaquinorocha@gmail.com
Received: 21 March 2026.
Accepted: 29 July 2026.
Editor: Osvaldo Luiz Gonsalves Quelhas.

These digital solutions have the potential to enhance team coordination, project quality, and visibility over schedules and costs, thereby addressing longstanding challenges within the construction sector and contributing to a more productive and sustainable industry (Mesáros et al., 2021).

In recent years, several digital management tools have been examined in studies related to the construction industry. Among the most notable are Primavera P6 (Desai et al., 2022), Sienge (Chaves, 2022), Totvs, SAP, and Oracle ERP (Santos et al., 2020), as well as VIGHA, Obrafit, and Agilean (Valente et al., 2021). Collectively, these systems reflect a growing trend toward the adoption of integrated digital solutions aimed at automating and modernizing construction processes.

Specialized literature and case studies have highlighted the effectiveness of platforms such as Sienge (Cunha & Café Filho, 2018; Quemelo, 2018; Lopes et al., 2020; Chaves, 2022), developed by Softplan, and Primavera P6, developed by Oracle (Pankaj et al., 2020; Nalawade et al., 2020; Desai et al., 2022), in supporting engineering project management.

To characterize the Brazilian market, a survey of the main construction management systems currently available was conducted (Table 1). Their functionalities were classified based on the framework proposed by Valente (2021), with the addition of criteria related to BIM support, client portals, and licensing models.

Table 1 - Main construction management systems available in the Brazilian market

Software	Cost management*	Planning & control**	Project management***	BIM Support	Client portal	License
Agilean	–	✓	✓	–	–	Trial
Construct App	–	–	–	–	–	Trial
Construon	–	✓	✓	–	–	Trial
Constructpoint	–	–	✓	–	–	Trial
MoBuss	–	–	✓	–	–	Trial
M² Obras	✓	✓	–	–	–	Paid
Obra Prima	✓	✓	✓	–	✓	Paid
Obrafit	–	–	✓	–	–	Trial
Omie	✓	–	✓	–	–	Free
Qualitab	–	–	–	–	–	Trial
Stant	–	✓	✓	–	–	Trial
VIGHA	✓	–	✓	–	–	Trial
Diário de Obra	–	–	✓	–	–	Trial
OrçaFascio	✓	✓	–	–	–	Trial
Primavera P6	–	✓	✓	–	–	Trial
Navisworks	–	–	–	✓	–	Paid
Arquimedes	✓	✓	–	–	–	Paid
MS Project	–	✓	✓	–	–	Trial
Monday.com	–	✓	✓	–	–	Trial
Project Libre	–	✓	–	–	–	Free
Sienge	✓	✓	✓	–	–	Trial
Synchro 4D	–	✓	–	✓	–	Paid
Vico	✓	✓	✓	✓	–	Trial
Obras.Gov	–	–	✓	–	–	Paid

*Cost Management = Budgeting (B) + Financial Management (FM)
** Planning & Control = Planning (P) + Measurement/Production (M/P)
*** Project Management = Construction Management (CM), Safety (S), Quality (Q), Post construction (PC), and Smartphone Support (SM)

Source: the authors.

Despite the progress observed in the private sector, the public sector still faces a notable shortage of systems tailored to its specific requirements, such as compliance with public procurement legislation and the transparency demanded of administrative actions (Softplan, 2019). Only the ObraFit and Obras.Gov software include the “client portal” functionality, which is essential

for public transparency. Among them, only Obras.Gov is specifically designed for the governmental sector, demonstrating the limited attention that software developers have given to this market niche.

The relevance of this gap becomes evident in light of the institutional diagnosis. In 2023, the Federal Court of Accounts (TCU) reported that, of approximately 21,000 registered federal projects, around 8,600 were halted — equivalent to 41% of the total (Brazil, 2023). This scenario underscores the urgency of developing tools that enhance the planning, execution, and monitoring of public works, thereby reducing waste and inefficiencies.

From a performance evaluation perspective, the literature indicates that the adoption of digital technologies tends to yield measurable improvements in Key Performance Indicators (KPIs) — namely quality, cost, and schedule — when integrated into adequate management and monitoring processes (Mesáros et al., 2021; Mostafa et al., 2020).

Internationally, consolidated sets of KPIs for construction projects encompass cost, quality, schedule, productivity, client satisfaction, profitability, and environmental impacts (Moradi et al., 2021; Mostafa et al., 2020; Demirkesen & Ozorhon, 2017; Nguyen et al., 2013). Furthermore, authors such as Mesáros et al. (2021), Kärkkäinen et al. (2019), and Pinheiro & Crivelaro (2018) emphasize that the strategic selection of indicators, aligned with organizational objectives, is a determining factor for management systems to achieve tangible performance gains.

Given the shortage of management tools specifically designed for the public sector and the need for more effective public works administration, this study critically evaluates e-Obras, a digital platform developed by Softplan and implemented by the Government of the State of Amazonas, Brazil, for managing public infrastructure projects. The platform integrates contractual, financial, and execution data to enhance transparency, accountability, and decision-making throughout the project lifecycle.

As public organizations increasingly adopt cloud-based digital platforms to manage sensitive contractual, financial, and administrative information, cybersecurity and data governance have become important considerations. Cloud computing environments may be exposed to vulnerabilities associated with identity management, insecure interfaces, weak access controls, unauthorized access, and other security threats (Addula et al., 2025). These risks are particularly relevant in critical infrastructure environments, where failures in information security may compromise transparency, accountability, and operational continuity.

Consequently, modern digital management platforms should incorporate appropriate security, governance, and risk-mitigation mechanisms to ensure information integrity and reliability. In particular, robust authentication, multi-factor access control, and data protection mechanisms are increasingly recognized as essential components of cloud-based digital infrastructures handling sensitive public-sector information (Konda et al., 2022). Although cybersecurity, cloud security, and data protection were not included within the scope of the present evaluation framework, they represent important complementary dimensions for future assessments of public-sector digital systems. Furthermore, robust cybersecurity mechanisms, including secure authentication, access control, data protection, and auditability, are essential for ensuring the confidentiality, integrity, and availability of sensitive contractual and financial information managed by public-sector digital platforms. These aspects complement traditional project management functionalities and contribute to trustworthy digital governance.

Despite the growing adoption of digital technologies in construction, studies evaluating platforms specifically developed for public works remain scarce, particularly from the perspective of performance indicators and governance requirements. To address this gap, this study proposes and applies the Public Works Management System Checklist (PWMSC), a specialist-validated framework designed to assess the extent to which digital platforms support key performance indicators related to cost, schedule, scope, quality, environment, and occupational health and safety. Using e-Obras as a case study, the research identifies strengths, limitations, and opportunities for improvement, thereby contributing to the broader discussion on the digital transformation and modernization of public works management in Brazil and other public-sector contexts.

2 METHODOLOGY

This study presents a critical analysis of the e-Obras public works management system, focusing on its ability to support the monitoring of key performance indicators related to cost, schedule, scope, quality, environment, and occupational health and safety. The research methodology was organized into three main stages: (a) development of the PWMSC; (b) application of the checklist to the e-Obras platform; and (c) analysis and discussion of the results.

2.1 Development of the PWMSC

Following the identification of the performance indicators, a panel of experts was consulted using the Delphi method, a widely adopted approach for obtaining structured expert judgment while minimizing the influence of group bias (Duarte & Piffer, 2021). Participants were selected based on their recent and direct experience in areas related to public works management and construction project performance assessment. The expert panel included researchers, university professors, and public servants working in project management, public infrastructure agencies, and government oversight institutions.

A total of 30 experts were invited to participate in the study, of whom 16 provided valid responses, resulting in a response rate of 53.3%. This participation rate is considered satisfactory, as Delphi studies commonly report non-response rates ranging from 20% to 50% per round (Marques & Freitas, 2018). The collected data were analyzed using two complementary criteria: the Level of Consensus (LC) and the Content Validity Index (CVI).

To evaluate the proposed items, the experts used a five-point Likert scale ranging from 1 ("not important") to 5 ("very important"). The LC was determined according to the classification proposed by Mostert-Phipps et al. (2013), which categorizes the degree of agreement among participants into four levels: high, moderate, low, and none. High consensus was considered to be achieved when 70% of responses converged within a single category or 80% within two adjacent categories. Moderate consensus was defined as 60% of responses within a single category or 70% within two adjacent categories, whereas low consensus corresponded to 50% and 60%, respectively. No consensus was considered to exist when fewer than 60% of responses were concentrated within two adjacent categories.

To evaluate the relevance of each item, the CVI was calculated using the procedure proposed by Grant and Davis (1993), as presented in Equation (1).

$$CVI = \frac{Number\ of\ responses\ rated\ "4"\ or\ "5"}{Total\ number\ of\ responses} \qquad \text{Equation (1)}$$

According to Grant and Davis (1993), a CVI value of at least 0.80 is required to establish the content validity of a newly developed instrument. Accordingly, a criterion was retained in the PWMSC when it achieved a high or moderate level of consensus and a CVI equal to or greater than 0.80. The indicator selection procedure adopted in this study is summarized in Figure 1.

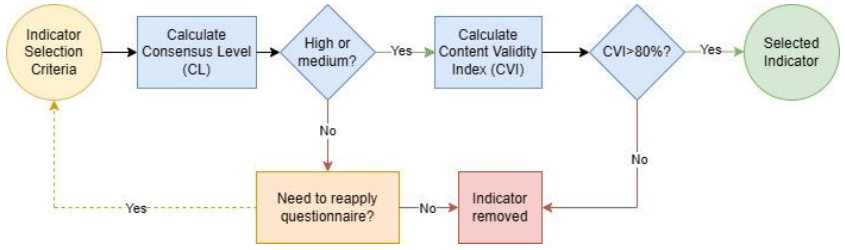

Figure 1 - Flowchart for the selection of indicators
Source: adapted from Machado (2018).

Based on the validation results, the PWMSC was developed as a structured framework comprising the criteria and indicators approved by the expert panel. The outcomes of the Delphi validation process, including the LC and CVI values for each criterion, are presented in Table 2.

According to the acceptance criteria established in the methodology, items 1.7, 2.7, 4.2, 4.6, 5.3, 6.2, 6.3, 6.4, 6.5, and 6.6 were excluded from the final version of the checklist. The greatest variability in expert assessments was observed for the Occupational Health and Safety category, indicating lower levels of agreement regarding the relevance of some indicators within this dimension.

Table 2 - Development and validation of the PWMSC

Item	Question	Criteria		
		LC	CVI	Indicator
1	**Cost**			
1.1	The system provides access to the original budget for consultation.	High	100	Yes
1.2	The system displays the number of	High	100	Yes

	financial addenda.			
1.3	The system displays the total amount of financial addenda.	High	93.7	Yes
1.4	The system shows the number of contractual changes related to financial rebalancing.	High	80	Yes
1.5	The system shows the total amount of contractual changes related to financial rebalancing.	High	86.6	Yes
1.6	The system allows monitoring of planned vs. executed expenditure.	High	87.4	Yes
1.7	The system monitors the Cost Performance Indicator (CPI) based on the Earned Value (EV) methodology.	Moderate	62.5	No
1.8	The system includes a field to identify contractual changes related to cost.	High	86.6	Yes
2	**Schedule**			
2.1	The system provides access to the initial project schedule for consultation.	High	93.7	Yes
2.2	The system displays a detailed activity schedule, allowing identification of predecessors and successors.	High	81.2	Yes
2.3	The system displays the number of contractual changes (addenda) related to the project execution schedule.	High	87.4	Yes
2.4	The system displays the total amount of contractual changes (addenda) related to the project execution schedule.	High	80	Yes
2.5	The system shows the number of project interruptions that occurred during execution.	High	81.2	Yes
2.6	The system displays the total cost of project interruptions that occurred during execution.	High	80	Yes
2.7	The system monitors the Schedule Performance Indicator (SPI) based on the Earned Value (EV) methodology.	None	56.3	No
2.8	The system includes a field to identify contractual changes related to the project schedule.	High	80	Yes
3	**Scope**			
3.1	The system provides access to the original project scope for consultation.	High	93.7	Yes
3.2	The system provides a list of added and removed services without performing compensation.	High	87.5	Yes
3.3	The system includes a field to identify the origin of scope changes.	High	93.7	Yes
4	**Quality**			
4.1	The system enables the monitoring of guidelines established by the Brazilian Performance Standard NBR 15.575.	Moderate	75	No
4.2	The system enables the monitoring of guidelines established by the Brazilian Program for Quality and Productivity in Housing.	Moderate	73.4	No
4.3	The system allows quality monitoring based on information from the Service Verification Form.	High	80	Yes
4.4	The system records completed services	High	81.2	Yes

	that required rework.			
4.5	The system quantifies post-construction technical assistance requests.	High	86.6	Yes
4.6	The system records the client satisfaction level at the end of the project.	Moderate	74.9	No
5	**Environment**			
5.1	The system monitors compliance with environmental licensing stages (License Renewal).	High	93.7	Yes
5.2	The system supports compliance with environmental licensing stages at the end of the project (Operating License).	High	86.6	Yes
5.3	The system monitors the generation rate of Construction and Demolition Waste (CDW).	Low	68.7	No
5.4	The system quantifies project-related incidents (notifications, warnings, and fines).	High	81.2	Yes
6	**Occupational health and safety**			
6.1	The system enables the monitoring of guidelines established in the Risk Management Program (RMP).	High	86.7	Yes
6.2	The system records the number of non-conformities related to the use of Personal Protective Equipment (PPE) and Collective Protective Equipment (CPE).	Moderate	75	No
6.3	The system presents the number of work-related accidents and fatalities.	Moderate	75	No
6.4	The system records the number of days of work absence resulting from accidents.	Low	62.5	No
6.5	The system quantifies the project's legal incidents (notifications, warnings, and fines).	Low	62.5	No
6.6	The system records the total amount spent on compensation in labor disputes.	None	50	No

Source: the authors.

Although Delphi studies commonly involve multiple rounds, a second round was not conducted because the first round already achieved satisfactory levels of consensus and content validity according to the predefined acceptance criteria. All retained criteria achieved moderate or high consensus and CVI values equal to or greater than 0.80, whereas those that failed to meet these thresholds were excluded from the final checklist. Furthermore, the experts did not provide substantial recommendations requiring the reformulation of the proposed criteria. Consequently, an additional round was considered unlikely to significantly influence the final outcome while potentially increasing participant attrition. This decision is consistent with Machado (2018), who reported that subsequent Delphi rounds may be unnecessary when satisfactory consensus has already been achieved and the likelihood of meaningful changes is low.

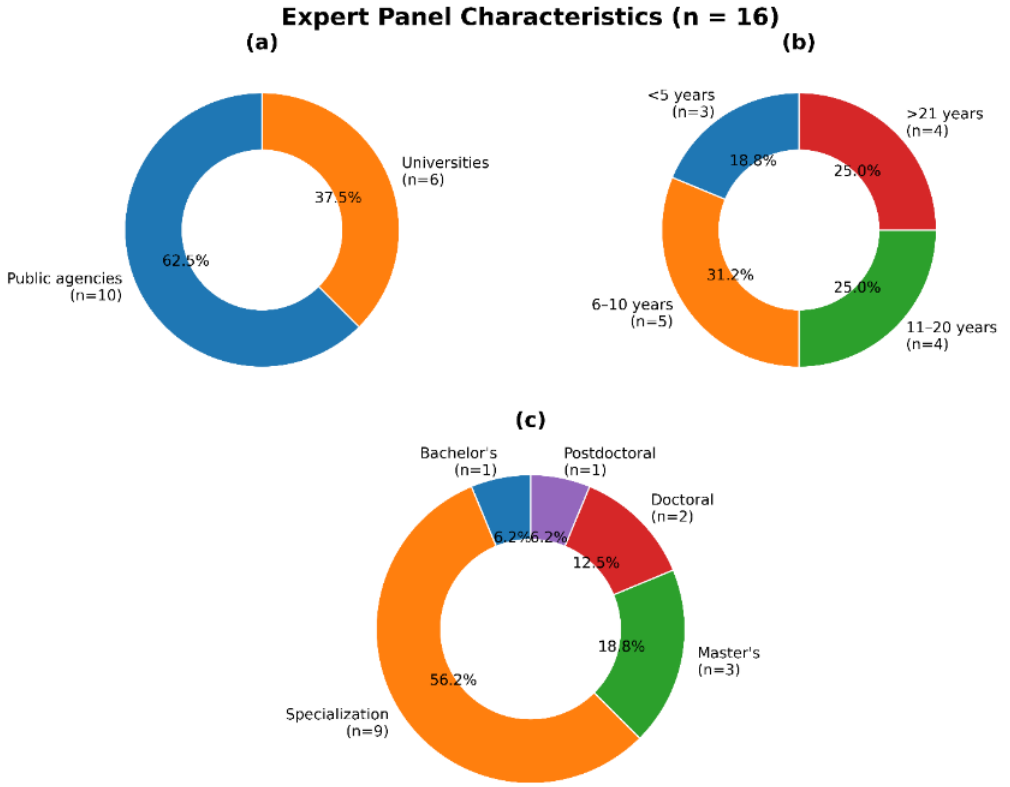

Figure 2 - Expert panel characteristics: (a) institutional affiliation; (b) professional experience; and (c) academic qualifications

Source: the authors.

The expert panel comprised 16 specialists from public institutions and universities. As illustrated in Figure 2, 62.5% of the participants were affiliated with public agencies, while 37.5% were associated with higher education institutions. Regarding professional experience, 81.2% had more than five years of experience, and 50.0% had more than ten years of experience in public works management, construction management, project supervision, government auditing, and academic research. In terms of academic qualifications, the majority of participants held postgraduate degrees, including specialization (56.2%), master's (18.8%), doctoral (12.5%), and postdoctoral (6.2%) qualifications, highlighting the strong expertise represented within the panel.

2.2 Application of the checklist

The PWMSC was applied between October 2022 and February 2023 through a systematic evaluation of the e-Obras platform. Data collection was performed by the researcher using direct observation, one of the evidence-gathering techniques recommended for case study research by Yin (2005).

To ensure a comprehensive assessment of the platform's functionalities, the evaluation considered the three principal user profiles available in the system: Management and Supervision, Oversight Agencies, and the General Public. Access was officially granted by the State Department of Infrastructure of Amazonas, the institution responsible for the administration of the platform.

The assessment was contextualized using a dataset of 13 standardized projects from the Full-Time Education Center (CETI) program managed within the platform. The investigation involved a systematic examination of the available modules to verify compliance with the PWMSC criteria. Particular attention was given to functionalities associated with resource management, project progress monitoring, information transparency, and decision-support capabilities. The use of standardized public building projects provided a homogeneous contractual and managerial context, allowing a consistent evaluation of the platform functionalities while minimizing variability associated with different project types. Nevertheless, future studies should apply the PWMSC to a broader range of public works projects and digital management platforms to further assess its external applicability.

2.3 Analysis of results

In this stage, the information obtained from the checklist application was examined using both qualitative and quantitative approaches. The performance of the e-Obras platform was assessed by verifying its compliance with the criteria validated through the PWMSC. The objective was to determine the extent to which the platform supports the monitoring and management of performance indicators, rather than directly influencing project outcomes.

The findings were organized according to the six performance dimensions considered in the study: Cost, Schedule, Scope, Quality, Environment, and Occupational Health and Safety (Figure 3). This structured assessment enabled the identification of operational patterns, such as the predominance of traditional management indicators, as well as functional gaps associated with the absence of features supporting critical performance dimensions. Based on these observations, opportunities for improving the platform were proposed.

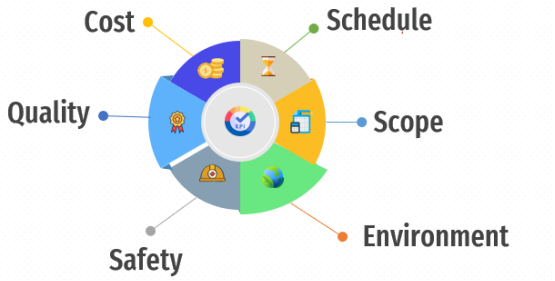

Figure 3 - Performance indicators considered in the evaluation framework
Source: the authors.

The assessment provided a detailed diagnosis of the strengths and limitations of the e-Obras platform. Nevertheless, as the study is based on a single case study, caution should be exercised when extending the findings to other public works contexts or management systems. The results provide valuable insights into current practices and trends but should not be interpreted as universally representative of the sector.

3 PRESENTATION AND ANALYSIS OF RESULTS

3.1 Analysis of indicators in the digital construction management system

3.1.1 Cost indicator

The first dimension evaluated was Cost. The results showed that the platform complied with six of the seven criteria established in the PWMSC, demonstrating adequate support for budget registration, financial amendments, and contractual rebalancing procedures. However, the functionality related to the dynamic monitoring of project expenditures (Item 1.6) did not fully satisfy the established requirements. The financial dashboard presented inconsistencies in the S-curve information (Planned versus Actual), including outdated records that may compromise the reliability of managerial analyses. However, the present study did not investigate whether these discrepancies resulted from platform limitations or delayed data updating by users. Since the objective of this research was to evaluate the functionalities available in the platform rather than the quality of data entered during its operation, no distinction between these factors was made.

Another limitation concerns the platform's historical data analysis capability. Financial information can only be visualized within a 12-month time horizon, restricting the assessment of long-term projects and preventing a consolidated evaluation of financial performance throughout the entire project lifecycle. Such limitations may affect strategic planning and decision-making, particularly in public infrastructure projects with multi-year execution periods.

Despite these shortcomings, the platform is strongly aligned with the requirements of Brazilian public procurement legislation, including Law No. 8,666/1993 and Law No. 14,133/2021. The system incorporates mechanisms that prevent the registration of cost increases exceeding the legal thresholds established by these regulations, thereby supporting compliance and financial control throughout project execution.

3.1.2 Schedule indicator

The Schedule dimension also demonstrated a high level of compliance, satisfying six of the seven criteria established in the PWMSC. The principal shortcoming was associated with the preparation and monitoring of detailed activity schedules (Item 2.2). The e-Obras platform adopts a monitoring approach predominantly focused on financial control, grouping activities by service categories rather than providing a sequential representation of construction processes through predecessor–successor relationships and real-time physical progress updates. As a result, project visualization is constrained, limiting proactive planning, schedule control, and the early identification of potential deviations.

One possible strategy to overcome this limitation is the integration of e-Obras with specialized planning and production control tools. Notably, Softplan, the developer of e-Obras, recommends connecting its ERP solutions with platforms such as Prevision to support more detailed monitoring of construction progress (GESCON, 2021). Such interoperability could enhance schedule reliability, improve planning accuracy, and support more informed managerial decisions.

Conversely, a notable strength of the platform is the "Live Construction Map" functionality available through the Client Portal. This feature demonstrated robust performance by providing transparent, reliable, and up-to-date information on contract execution, thereby facilitating public access to project information and strengthening accountability.

3.1.3 Scope indicator

Completing the assessment of the indicators comprising the project management iron triangle, the analysis focused on the Scope dimension. The evaluation of the e-Obras platform produced highly satisfactory results, achieving full compliance with all criteria established in the PWMSC. Nevertheless, despite this positive performance, the qualitative assessment revealed a relevant managerial limitation: the absence of a mechanism for standardizing the registration of technical justifications associated with scope modifications.

The incorporation of such functionality would enable the systematic categorization and analysis of the factors leading to contractual amendments. This would facilitate the identification of recurring patterns, including design deficiencies, unforeseen site conditions, or client-driven changes, thereby supporting the development of preventive and corrective actions in future projects. Furthermore, the standardized documentation of scope modifications could strengthen transparency, traceability, and stakeholder alignment throughout the project lifecycle.

3.1.4 Quality indicator

Quality management in construction projects extends beyond compliance verification and encompasses a broad set of performance measures aimed at ensuring continuous improvement throughout the project lifecycle. The literature highlights the importance of monitoring indicators such as Service Verification Forms (SVFs), rework rates, performance assessments, and post-construction technical assistance records.

The evaluation of the e-Obras platform revealed a complete absence of functionalities capable of supporting these quality-related dimensions. Consequently, none of the criteria validated in the PWMSC for this category were satisfied. The only feature indirectly associated with quality management is a subjective assessment field included in the technical inspection form, which allows inspectors to evaluate the "Visual Aspect of the Construction." However, this functionality is not supported by objective criteria, standardized procedures, or mechanisms for generating consolidated information.

This limitation is particularly significant because the platform lacks tools for the systematic collection, storage, and analysis of quality-related information throughout project execution. As a result, any assessment of quality performance requires manual compilation of records from multiple documents, increasing the time required for analysis and the likelihood of inconsistencies or human error.

Furthermore, several indicators commonly associated with quality-oriented project management—including technical assistance costs, client satisfaction levels, service request frequency, and rework occurrence—are not monitored by the platform. The absence of these functionalities restricts the ability of managers to evaluate project performance comprehensively and to implement evidence-based corrective or preventive actions aimed at continuous improvement.

3.1.5 Environment indicator

Similar to the findings obtained for the Quality dimension, the evaluation revealed a complete absence of environmental management functionalities within the e-Obras platform, resulting in non-compliance with all criteria established in the PWMSC. Although a valid environmental license is required during project registration, the platform does not provide mechanisms to support the continuous monitoring of environmental performance throughout project execution. Specifically, no tools were identified for tracking license renewals (Item 5.1) or for recording environmental occurrences arising from regulatory inspections, such as notifications, warnings, or fines issued by competent authorities (Item 5.4).

This limitation reduces environmental oversight to a predominantly administrative requirement that remains external to the platform and is managed primarily through contractual obligations between the project owner and the contractor. Consequently, the system is unable to generate environmental performance data, automated alerts, or decision-support information that could facilitate a more proactive and integrated approach to environmental governance. The absence of these functionalities restricts the capacity of managers to monitor environmental compliance systematically and to respond effectively to potential risks throughout the project lifecycle.

3.1.6 Occupational health and safety indicator

The analysis of the Occupational Health and Safety (OHS) dimension revealed that the e-Obras platform did not satisfy the only criterion retained after the Delphi validation process. Specifically, no dedicated module was identified for monitoring the requirements of the Risk Management Program (RMP). The sole functionality associated with this topic is a questionnaire embedded within the technical inspection report, which includes fields for recording the use of Personal Protective Equipment (PPE) and the occurrence of workplace accidents. Although these questionnaire fields allow the recording of basic OHS information, they function only as isolated data-entry fields and are not integrated into a dedicated management module capable of consolidating information, monitoring indicators, generating reports, or supporting decision-making. Consequently, according to the PWMSC evaluation criteria, the platform was considered non-compliant with the validated OHS management requirements.

Although these records may provide basic documentation related to occupational safety, the platform does not offer mechanisms for consolidating, monitoring, or managing this information in a systematic manner. Consequently, OHS-related records remain fragmented and are not incorporated into consolidated management reports, such as the Contract Summary Sheet, which provides an overview of contractual activities. Access to safety-related information therefore depends on manual consultation of individual inspection reports, limiting the identification of trends and reducing the ability of managers to implement preventive actions aimed at mitigating occupational risks.

The consolidated assessment of all performance dimensions reveals a clear imbalance in the design philosophy of the e-Obras platform. High levels of compliance were observed for the traditional project management iron triangle, with compliance rates of 93% for Cost, 86% for Schedule, and 100% for Scope. In contrast, no compliance was identified for the Quality, Environment, and Occupational Health and Safety dimensions. A summary of these results is presented in Figure 4.

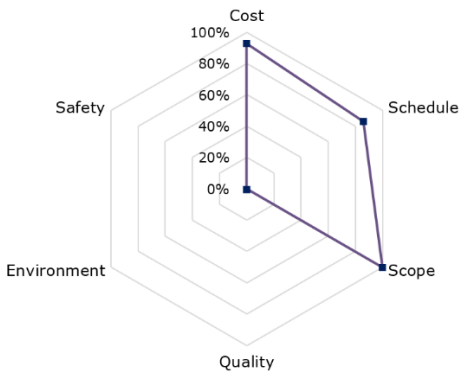

Figure 4 - Compliance of the e-Obras platform with the evaluated performance dimensions

Source: the authors.

These findings indicate that the platform is primarily oriented toward contractual, administrative, and financial control, while providing limited support for dimensions associated with quality management, environmental performance, and occupational safety. As a result, its contribution to integrated project management remains restricted. Nevertheless, the identified gaps also represent significant opportunities for future development, particularly through the incorporation of functionalities capable of supporting sustainability, safety, quality assurance, and more comprehensive performance monitoring throughout the project lifecycle.

3.2 Opportunities for improvement

Several opportunities for enhancing the e-Obras platform were identified based on the gaps observed during the evaluation process. These proposed improvements aim to strengthen project monitoring from the planning stage through project completion and post-delivery follow-up, while promoting greater transparency, efficiency, sustainability, and compliance with safety requirements (Figure 5).

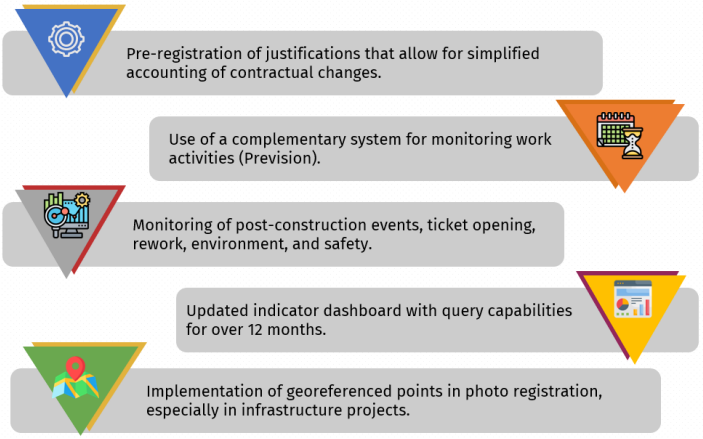

Figure 5 - Opportunities for improvement in the e-Obras platform

Source: the authors.

The recommendations presented below derive directly from the weaknesses identified during the assessment and encompass both technical and managerial enhancements.

One important opportunity relates to the standardization of justifications for contractual modifications. Although the Scope dimension achieved full compliance (100%), no mechanism currently exists to classify and organize the causes of project changes. The implementation of a dedicated registration module with predefined categories (e.g., design deficiencies, client requests, or unforeseen site conditions) would transform qualitative records into structured information, enabling quantitative analyses of the root causes of contractual amendments and supporting more effective corrective actions.

Another area requiring attention is the planning and physical control of activities. The evaluation revealed a strong emphasis on financial monitoring, whereas detailed production planning receives comparatively limited support. Integrating e-Obras with specialized planning software through Application Programming Interface (API) connections would enable the importation of detailed schedules incorporating activity sequencing and dependencies, thereby facilitating more proactive schedule management aligned with actual site conditions.

The results also highlight the need for dedicated modules addressing Quality, Environment, and OHS, as no compliance was observed for these dimensions. Potential functionalities include:

- Quality: digital management of SVFs, recording of non-conformities, and integration of technical assistance records.
- Environment: automated monitoring of environmental license validity and systematic recording of environmental notifications, warnings, and fines issued by regulatory authorities.
- OHS: digital monitoring of RMP requirements, including the registration of inspections, incidents, and safety-related observations.

Another limitation identified concerns the financial dashboard, which currently restricts data visualization to a 12-month period. Expanding this functionality to allow comprehensive historical analyses would improve the monitoring of long-term projects and provide a more complete understanding of financial performance throughout the project lifecycle.

Additionally, incorporating georeferencing capabilities into photographic records could strengthen traceability and transparency. Embedding geographic coordinates into images would facilitate the verification of activity locations, improve documentation quality, and support more effective control of physical progress and on-site events.

Beyond these specific improvements, emerging Industry 4.0 technologies offer significant opportunities to further enhance digital construction management platforms. Although the PWMSC was developed to evaluate support for traditional public works performance indicators, technologies such as the Internet of Things (IoT), predictive analytics, artificial intelligence, and advanced cybersecurity mechanisms can substantially improve real-time monitoring, decision-making, and risk management. Future versions of the framework may therefore incorporate criteria related to digital maturity and Industry 4.0 capabilities.

In particular, the absence of environmental and OHS functionalities represents one of the most promising areas for future development. Recent advances in digital construction management have demonstrated the potential of IoT devices, connected sensors, and automated data acquisition systems to support real-time monitoring of environmental and safety conditions. Examples include monitoring worker exposure to hazardous situations, tracking environmental parameters such as dust, noise, and emissions, and generating automatic alerts when predefined thresholds are exceeded. The incorporation of such technologies could substantially strengthen environmental and safety governance throughout the project lifecycle.

Future developments may also consider broader digital governance dimensions. The current PWMSC focuses on evaluating functionalities associated with public works performance indicators and therefore does not assess cybersecurity, data protection, auditability, cloud security, or access control mechanisms. Nevertheless, these aspects are increasingly relevant for public-sector digital platforms and should be considered in future evaluation frameworks.

It is also important to recognize that the present study assessed the functional capabilities of the e-Obras platform rather than its technological robustness. Consequently, aspects such as system reliability, data integrity, service availability, and protection against unauthorized access or data manipulation were not examined. The benefits identified in this study should therefore be interpreted as potential managerial advantages associated with the available functionalities rather than verified evidence of overall technological performance. Future investigations should explore these dimensions to provide a more comprehensive assessment of public works management platforms.

4 CONCLUSIONS

The PWMSC proved to be an effective framework for evaluating digital management systems through key performance dimensions, including cost, schedule, scope, quality, environment, and occupational health and safety. As a flexible assessment tool, it enables organizations to identify the extent to which a platform meets their operational requirements while allowing the inclusion or exclusion of criteria according to specific institutional needs.

The evaluation of the e-Obras platform demonstrated high levels of compliance with the traditional project management dimensions of Cost (93%), Schedule (86%), and Scope (100%). Nevertheless, opportunities for improvement were identified, particularly regarding the standardization of contractual change justifications, the integration of advanced planning functionalities, and the enhancement of performance reporting mechanisms. In contrast, no compliance was observed for the Quality, Environment, and Occupational Health and Safety dimensions, revealing significant gaps in the platform's support for comprehensive project performance management.

These findings suggest that the development of digital solutions for public works remains strongly oriented toward contractual and financial control, with comparatively limited attention given to quality management, sustainability, and occupational safety. Consequently, digital platforms often function primarily as repositories of administrative records rather than as integrated tools capable of supporting proactive project governance.

The practical implications of these findings are twofold. For public managers, the results demonstrate that the adoption of digital technologies alone does not guarantee effective project management if critical performance dimensions remain unaddressed. For software developers, the identified gaps highlight a clear opportunity to incorporate Quality, Health, Safety, and Environment (QHSE) functionalities into future generations of public-sector management platforms.

The proposed framework is not restricted to the e-Obras case study. Because it is based on performance dimensions commonly adopted in construction project management, the PWMSC can be adapted and applied to other public or private platforms, supporting comparative evaluations, software selection processes, and continuous improvement initiatives. Future research may also

investigate the implications of the absence of quality, environmental, and safety indicators during the operation and maintenance phases of public facilities.

A limitation of this study relates to the composition of the Delphi panel used to validate the PWMSC. Although the 16 experts were selected based on their professional experience and expertise in public works management, construction management, government auditing, and academic research, the panel cannot be considered fully representative of all regions and institutions involved in public works management at the national level. Consequently, the results should be interpreted as an expert-based validation rather than a nationwide validation of the proposed framework. Future studies are encouraged to expand both the number and geographic diversity of participants to further strengthen the robustness and applicability of the checklist.

Another limitation of the PWMSC is that all validated criteria were assigned equal weight in the compliance assessment. Although this approach facilitated the development, validation, and practical application of the framework, it does not account for differences in the relative importance, complexity, or managerial impact of individual functionalities. Future studies may explore weighting schemes based on expert judgment, multicriteria decision-making techniques, or statistical approaches to provide more refined assessments. In addition, future research should validate the PWMSC across a wider variety of public works projects with different levels of complexity and operating contexts, as well as incorporate complementary dimensions related to cybersecurity, data protection, and privacy. These enhancements would broaden the framework's applicability and provide a more comprehensive assessment of digital management platforms used in the public sector.

Despite these limitations, the PWMSC demonstrated its value as a structured framework for evaluating digital management platforms from a performance-oriented perspective. Beyond the specific case of e-Obras, the study contributes to the broader discussion on the digital transformation of public works management by emphasizing that effective project governance should extend beyond the traditional cost–schedule–scope triangle to encompass quality, environmental, and occupational health and safety dimensions. Ultimately, the findings highlight the need for a new generation of public-sector digital platforms capable of supporting transparency, sustainability, safety, and evidence-based decision-making throughout the entire project lifecycle.

REFERENCES

Addula, S.R., Norozpour, S. and Amin, M. (2025), "Risk assessment for identifying threats, vulnerabilities and countermeasures in cloud computing", Jordanian Journal of Informatics and Computing, Vol. 2025 No. 1, pp. 37–48.

Chaves, C.M.E. (2022), Aplicação automatizada do lean construction por ferramenta computacional, Undergraduate Thesis in Civil Engineering, Universidade Católica de Goiás, Goiás.

Cunha, W.S. and Caffé Filho, H.P. (2019), "Gestão de obras públicas: logística mais adequada ao cumprimento dos prazos planejados", Id on Line Revista Multidisciplinar e de Psicologia, Vol. 13, No. 45, pp. 77–89.

Demirkesen, S. and Ozorhon, B. (2017), "Impact of integration management on construction project management performance", International Journal of Project Management, Vol. 35, No. 8, pp. 1671–1683.

Desai, N.V. et al. (2023), "Increasing the potential application of Microsoft Project and Primavera P6 for project management: A comparative analysis of residential project", Materials Today: Proceedings, Vol. 77, No. 1, pp. 794–804.

Duarte, V.N. and Piffer, M. (2021), "Caracterização do método Delphi: aspectos teóricos e metodológicos", in Simpósio Latino-Americano de Estudos de Desenvolvimento Regional, SLAEDR, pp. 1–10.

Enshassi, A., Mohamed, S. and Abushaban, S. (2015), "Factors affecting the performance of construction projects in the Gaza Strip", Journal of Civil Engineering and Management, Vol. 21, No. 6, pp. 670–680.

Farias, J.C. (2020), O que é o Navisworks?, SPBIM Arquitetura Digital, available at: https://spbim.com.br/o-que-e-navisworks/

Gescon (2021), ERP para construção na prática, video, NUPRE UFSCAR, available at: https://www.youtube.com/watch?v=bmeoqGc5fao

Grant, J.S. and Davis, L.L. (1993), "Guidelines for using psychometric consultants in nursing studies",

Research in Nursing & Health, Vol. 16, No. 2, pp. 151–155.

Guimarães, L. (2024), Construção civil: quais são os principais insights do setor, Construção Latino-Americana, available at: https://www.construcaolatinoamericana.com

Kärkkäinen, R. et al. (2019), "Situation picture through construction information management", in Nordic Conference on Construction Economics and Organization, pp. 155–161.

Konda, B. et al. (2022), "Homomorphic encryption and federated attribute-based multi-factor access control for secure cloud services in integrated space-ground information networks", International Journal of Communication and Information Technology, Vol. 3, No. 2, pp. 33-40.

Likert, R. (2022), "A technique for the measurement of attitudes", in Woodworth, R.S. (Ed.), Archives of Psychology, The Science Press.

Lopes, A.F.D. et al. (2020), "Análise de aplicativos para o gerenciamento de obras: uso para diário de obras", in Encontro Nacional de Tecnologia do Ambiente Construído, ANTAC, Porto Alegre, pp. 9–23.

Machado, F.H. (2018), Proposição de indicadores de segurança hídrica: seleção, validação e aplicação na bacia hidrográfica do rio Jundiaí-Mirim, Doctoral Thesis in Civil Engineering, Universidade Estadual Paulista, São Paulo.

Marques, J.S. and Freitas, W.S. (2018), "O método Delphi: caracterização e potencialidades na pesquisa em educação", Pro-Posições, Vol. 29, No. 2, pp. 395–415.

Mattos, A.D. (2019), Planejamento e controle de obras, Oficina de Textos, São Paulo.

Mellado, F. et al. (2019), "Synthesising performance in the construction industry", Engineering, Construction and Architectural Management, Vol. 27, No. 2, pp. 579–608.

Mesáros, P. et al. (2021), "Impact of enterprise information systems on selected key performance indicators in construction project management", Wireless Networks, Vol. 27, No. 3, pp. 1641–1648.

Moradi, S. et al. (2021), "A systematic analysis of construction performance management", Iranian Journal of Science and Technology, Transactions of Civil Engineering, Vol. 46, No. 1, pp. 15–31.

Mostafa, K. et al. (2020), "BIM applications toward key performance indicators of construction projects in Iran", International Journal of Construction Management, Vol. 20, No. 4, pp. 305–320.

Mostert-Phipps, N., Pottas, D. and Korpela, M. (2013), "A South African perspective on factors that impact on the adoption and meaningful use of health information technologies", South African Family Practice, Vol. 55, No. 6, pp. 545–554.

Nalawade, S. et al. (2019), "Earned value analysis of construction project using Primavera P6", Cikitusi Journal for Multidisciplinary Research, Vol. 6, No. 5, pp. 514–522.

Nguyen, T.A., Chovichien, V. and Takano, S.-E. (2013), "Quantitative weighting for evaluation indexes of construction project success by structural equation modeling", International Journal of Construction Engineering and Management, Vol. 3, No. 2, pp. 70–84.

Pankaj, V. et al. (2020), "Effective scheduling and control of construction project using Primavera P6: A review", Studies in Indian Place Names, Vol. 40, No. 50, pp. 5050–5064.

Peinado, H. and Melo, A. (2022), "Implantação de um software para controle da produção em uma construtora de pequeno porte", Gestão e Engenharia de Produção, Vol. 4, No. 1, p. 28.

Pinheiro, A.C.F.B. and Crivelaro, M. (2018), Gestão de contratos na construção civil, Érica, São Paulo.

Polito, G. (2015), Gerenciamento de obras: boas práticas para a melhoria da qualidade e da produtividade, Pini, São Paulo.

Quemelo, L.D. (2019), Avaliação do software Sienge segundo a norma ISO/IEC 25010, Undergraduate Thesis in Civil Engineering, Universidade Federal de Santa Catarina, Florianópolis.

Rabelo, N.N. (2022), Análise da segurança hídrica no estado do Ceará, Master's Thesis in Civil Engineering, Universidade Federal do Ceará, Ceará.

Sampaio, M.T.B. (2022), Desenvolvimento econômico e indústria: a indústria 4.0 e o aprimoramento tecnológico da produção local, Master's Thesis, Universidade Federal de Sergipe, Sergipe.

Santos, A.P.L. et al. (2020), "Análise da aderência dos sistemas ERP aos processos de planejamento e controle da construção", in Simpósio Brasileiro de Gestão e Economia da Construção, SIBRAGEC, pp. 1–10.

Softplan (2019), Webinar Obras.gov – Fiscalização e gestão de obras públicas, video, available at:

https://www.youtube.com/watch?v=r2Z3ZEuThT8

Szarnik, A. (2021), Os 12 melhores softwares de gestão de obras, Blog Obra Prima Web, available at: https://blog.obraprimaweb.com.br

Valente, M.P. (2021), Análise das informações e recursos obtidos em softwares de gestão de obras, Undergraduate Thesis in Civil Engineering, Universidade Federal de Uberlândia, Uberlândia.

Van der Heijden, J. (2023), "Construction 4.0 in a narrow and broad sense: A systematic literature review", Building and Environment, Vol. 244, 110788.

Author Contributions: HMRL, ACLJ: Conceptualization. HMRL, ACLJ: Methodology. HMRL, ACLJ: Investigation. HMRL, ACLJ: Data curation. HMRL, ACLJ, JHAR: Formal analysis. JHAR: Validation. HMRL, ACLJ, JHAR: Visualization. HMRL, ACLJ, JHAR: Writing – original draft. HMRL, ACLJ, JHAR: Writing – review & editing. ACLJ: Supervision.