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Optimización de Costes y Plazos en Proyectos de Edificación mediante un Sistema Integral de Gestión en un Contexto Urbano Emergente: Evidencia Empírica en la zona metropolitana de Lima, Perú Cost and Schedule Optimization in Building Projects Using an Integrated Management System in an Emerging Urban Context

John Miguel Pingo Román [a]; Tomás Gil López [b]; Amparo Verdú Vázquez [b]

[a] Departamento de Tecnología de la Edificación, Escuela Técnica Superior de Edificación de Madrid. Universidad Politécnica de Madrid (email: jpingo@grupojp.com.pe),

Resumen-- **Este estudio presenta la implementación y validación de un Sistema Integral de Gestión (SIG) orientado a optimizar los costes y plazos en proyectos de edificación multifamiliar en Lima Metropolitana, Perú. La investigación se desarrolló bajo un enfoque cuantitativo y un diseño pre-experimental, aplicando el SIG en cinco proyectos seleccionados según criterios de comparabilidad técnica, accesibilidad a información financiera y ubicación en un contexto urbano emergente. Los proyectos sin SIG presentaron un sobrecoste promedio del 8.82%, mientras que los gestionados con SIG se mantuvieron en 0.54%, incluso considerando el coste de gestión. En cuanto al tiempo, los retrasos promedio disminuyeron del 15.54% al 7.14%. Además, se observó un alto nivel de cumplimiento del sistema (superior al 90%), lo que refleja su viabilidad operativa y aceptación por parte de los equipos técnicos. El SIG demostró ser una herramienta eficaz para mejorar la trazabilidad, la coordinación interáreas y la toma de decisiones en obra, sin requerir inversiones tecnológicas elevadas. Estos hallazgos confirman la hipótesis de que una gestión integrada y estructurada puede mitigar las desviaciones críticas en proyectos de edificación, especialmente en contextos urbanos emergentes.**

Palabras clave— Gestión de proyectos de construcción; Optimización de costes y plazos; Sistema Integral de Gestión; Contexto urbano emergente.

Abstract— **This study presents the implementation and validation of an Integrated Management System (IMS) aimed at optimizing costs and deadlines in multifamily building projects in Metropolitan Lima, Peru. The research was developed under a quantitative approach and a pre-experimental design, applying GIS in five projects selected according to criteria of technical comparability, accessibility to financial information and location in an emerging urban context. Projects without GIS presented an average cost overrun of 8.82%, while those managed with GIS remained at 0.54%, even considering the cost of management. In terms of time, average delays decreased from 15.54% to 7.14%. In addition, a high level of compliance with the system was observed (over 90%), reflecting its operational viability and acceptance by the technical teams. GIS proved to be an effective tool to improve traceability, inter-area coordination and decision-making on site, without requiring high technological investments. These findings confirm the hypothesis that integrated and structured management can mitigate critical deviations in building projects, especially in emerging urban contexts.**

Index Terms— Construction project management; Cost and time optimization; Comprehensive Management System; Emerging urban context.

J.M.P.R. is PhD candidate at Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación de Madrid, Departamento de Tecnología de la Edificación. T.G.L. and A.V.V. are associate professor at Universidad Politécnica de Madrid, Escuela Técnica Superior de Edificación de Madrid.

I. INTRODUCTION

THE construction industry plays a fundamental role in the economic and social development of nations by generating employment, stimulating investment, and meeting housing and infrastructure needs. However, in most developing countries—including Peru—the sector faces structural challenges that compromise the efficiency of project execution, particularly cost overruns, schedule delays, and deficiencies in the quality of completed works (Vizcarra, 2018; Soto, 2019).

International studies have promoted the use of technologies such as Building Information Modeling (BIM) and approaches such as Lean Construction to improve efficiency, reduce waste, and support real-time decision-making (Koskela, 1992; Ballard & Howell, 2003). Although these solutions have demonstrated effectiveness in advanced contexts, their implementation in emerging economies faces significant barriers related to initial investment, training of technical personnel, and cultural resistance to change (Tinoco, 2020).

In the Peruvian context, digital platforms such as ERP S10 and PROCORE have been partially adopted by the private sector, while the government has promoted tools such as PERÚ COMPRAS for public procurement. Nevertheless, these solutions present important limitations: they do not integrate all project areas, involve high licensing costs, and are primarily suited for large-scale companies (Uguña, 2019; Vizcarra, 2018). Meanwhile, PERÚ COMPRAS, although driven by the State, is restricted to public procurement and lacks direct applicability or adaptability to private building projects (Vizcarra, 2018).

At the management level, the primary sources of inefficiency in building projects have been linked to failures in planning, scheduling, procurement, supervision, and control of construction processes. According to Enshassi et al. (2013) and Berrio (2016), the lack of coordination among stakeholders, unreliable information, and low standardization of procedures frequently cause budgetary and schedule deviations. Furthermore, material availability, purchase traceability, and proper workflow management are critical factors for ensuring continuity and productivity throughout the project (Thomas et al., 2003).

Several studies highlight that the absence of a structured management system during construction leads to high levels of uncertainty, difficulties in decision-making, and weak document control, all of which negatively impact cost and schedule performance. Meléndez (2022) identified that many Peruvian construction firms lack standardized process guidelines, resulting in reactive and costly management practices. In this regard, Azhar (2011) notes that digital tools such as BIM enhance project traceability and control from the design phase, while Ballard and Howell (2003) argue that Lean approaches help minimize waste and improve on-site productivity.

Given this scenario, it becomes essential to develop integrated management solutions tailored to the characteristics and limitations of the local construction environment. Accordingly, this article proposes the design, implementation, and validation of an Integrated Management System (IMS) aimed at optimizing cost and schedule control processes in building projects in Metropolitan Lima, Peru. Through a pre-experimental study, the impact of the IMS on performance indicators is empirically analyzed by comparing cases before and after its implementation.

This proposal seeks to contribute to the scientific body of knowledge by providing contextualized evidence aimed at improving operational efficiency in building projects in emerging economies, where the adoption of advanced technologies remains limited.

A recent study that applies multivariate cost-prediction models demonstrates the growing complexity of construction cost planning in emerging markets (Jiang et al., 2022).

Similarly, Abani and Ogedengbe (2024) found that the integration of cost-control practices significantly improves time and quality performance, highlighting the relevance of implementing an integrated management system within Peruvian contexts.

Another recent study conducts a systematic review of time–cost optimization models in construction management, demonstrating the increasing academic interest in this key performance variable (ElSahly, Ahmed & Abdelfatah, 2023).

In Latin American contexts, recent research shows that the low adoption of BIM methodologies is associated with higher costs and delays in construction projects (Rivera, 2024).

The recent framework proposed by Alnajjar, Atencio, and Turmo (2025) emphasizes the need to integrate Lean methodologies, BIM, and emerging technologies to optimize construction processes, opening opportunities to scale the system proposed in this research.

In recent Peruvian public works, cost overruns ranging from 8.8% to 52.2% and significant delays have been reported due to contractual and execution-related issues (Romero & Esenarro, 2024).

Furthermore, recent literature confirms that BIM integration throughout the project lifecycle supports cost and schedule optimization (Pacheco, 2024).

II. MATERIALS AND METHODS

A. *Methodological approach*

The research was conducted using a quantitative, applied, and longitudinal approach aimed at measuring the impact of the Integrated Management System (IMS) under real construction-site conditions. As stated by Ríos (2017), this type of methodological approach is suitable for interventions carried out in organizational contexts where full control over variables is not feasible. In this sense, a pre-experimental G–X–O design was employed, in which the independent variable (implementation of the IMS) was applied to a single group of projects under real operating conditions, and its effect on key cost and schedule indicators was subsequently measured.

This study followed a quantitative approach with an explanatory scope and a pre-experimental design. Its purpose was to evaluate the impact of implementing an Integrated

TABLE I
COST AND TIME INFORMATION OF PROJECTS WITHOUT A MANAGEMENT SYSTEM

TYPE	PROJECTS MANAGED WITHOUT A MANAGEMENT SYSTEM				
	CCU	MCH	ECOAQP	ECOSULL	ECOPIU
Initial cost	$ 9,808,538.43	$ 7,068,200.00	$ 21,673,231.76	$ 9,374,019.40	$ 20,472,721.13
Final cost	$ 3,057,183.71	$ 7,689,358.51	$ 23,875,073.66	$ 10,363,603.63	$ 21,655,562.69
Cost overruns	33.12%	8.79%	10.16%	10.56%	5.78%
Initial time	$ 240.00	$ 84.00	$ 120.00	$ 183.00	$ 120.00
Final time	$ 400.00	$ 96.00	$ 151.00	$ 205.00	$ 132.00
Time variation	66.67%	14.29%	25.83%	12.02%	10.00%
Management system	NO	NO	NO	NO	NO
Estimated management cost					
Management processes	$ -	0.00%	0.00%	0.00%	0.00%
Strategic processes	$	0.00%	0.00%	0.00%	0.00%

Management System (IMS) on the optimization of direct construction cost and execution time in building projects located in Metropolitan Lima, Peru. The selection of a quantitative approach responds to the need to obtain empirical evidence regarding the IMS's performance in optimizing direct cost and execution time—two critical variables in construction project management. As noted by Hernández-Sampieri and Mendoza (2018), this approach makes it possible to establish causal relationships between an intervention and the resulting outcomes, if data collection and analysis are conducted rigorously.

The study is framed as applied research, oriented toward solving a concrete problem in the construction sector: the significant deviations in cost and schedule typically observed during the project execution phase. Methodologically, the research relied on a pre-experimental G–X–O design, characterized by the observation of a single analysis group before and after the application of the stimulus (the IMS), without the inclusion of a control group.

B. Research Procedure

The methodological procedure consisted of five consecutive stages designed to evaluate the impact of the Integrated Management System (IMS) on urban building projects in Metropolitan Lima:

1) Identification of critical stages in a building project:

Based on the documentary analysis of technical files, interviews with construction managers, and the researcher's professional experience, the key stages that influence cost and schedule performance were identified.

2) Formulation of the baseline diagnosis:

Data were collected from fifteen projects executed between 2019 and 2023, all of which had reported cost and schedule deviations. From this sample, five projects were selected due to their comparable characteristics and accessibility to technical and financial information. A baseline was then established, documenting cost deviations (%) and schedule deviations (%) prior to the intervention.

3) Implementation of the IMS:

The system was deployed in the five selected projects. The involved personnel received training, on-site technical support was provided, and the IMS tools were applied in real time during project execution.

4) Evaluation and analysis of results:

Records of valuations, executed schedules, and technical reports were gathered. The key indicators—direct cost deviation (%), schedule deviation (%), and compliance with strategic and managerial processes—were compared before and after the implementation of the IMS.

5) Statistical Treatment:

The analysis was supported by descriptive statistical tools, using measures of central tendency and percentage-based comparisons. Comparative tables and scatter plots were developed to visualize the effects of the system and to identify variations in cost and schedule performance before and after implementation.

C. Population and Sample

The population consisted of fifteen multifamily building projects constructed in Metropolitan Lima over the past five years. Specific inclusion criteria were established to ensure the comparability and relevance of the cases analysed:

- Urban location
- Accessibility to technical and financial information
- Presence of deviations during the execution phase
- Comparable construction typology (multifamily buildings between five and ten stories).

The selection of Metropolitan Lima as the study setting responds to its condition as an emerging urban environment characterized by accelerated growth in housing demand, a high concentration of medium scale building projects, and technical infrastructure that is still in the process of consolidation. These characteristics make Lima a representative context for evaluating the effectiveness of integrated management systems in situations where resources are limited, planning is complex, and the risks of deviations are frequent. In addition, the diversity of stakeholders involved, and the heterogeneity of construction processes provide a robust empirical basis for validating the proposed model. From this population, a non-probabilistic purposive sampling method was applied, selecting ten pilot projects for the implementation of the system. This strategy enabled a longitudinal analysis under real construction-site conditions.

D. Techniques and Instruments

For data collection, techniques and instruments appropriate to the quantitative approach of the study were employed, with

TABLE II-A
COSTS AND SCHEDULES OF PROJECTS EXECUTED WITH THE IMS SYSTEM

	PROJECTS MANAGED WITH A MANAGEMENT SYSTEM				
TYPE	MOSAIQ	DLH	HDP	HPARDO	IG
Initial cost	$8,014,122.39	$26,494,864.55	$35,275,440.70	$ 13,699,335.80	$ 7,064,064.00
Final cost	$8,107,499.41	$26,256,275.71	$35,813,812.31	$ 13,585,394.93	$ 7,078,898.53
Cost variation	1.17%	-0.90%	1.53%	-0.83%	0.21%
Initial time	$ 420.00	$ 269.00	$ 365.00	$ 183.00	$ 365.00
Final time	$ 476.00	$ 290.00	$ 380.00	$ 205.00	$ 384.00
Time variation	13.33%	7.81%	4.11%	12.02%	5.21%
Management system	SÍ	SÍ	SÍ	SÍ	SÍ
Estimated management cost	4.00%	4.00%	4.00%	4.00%	4.00%
Management processes	92.50%	97.25%	92.75%	99.00%	95.00%
Strategic processes	87.50%	91.00%	97.00%	87.50%	97.50%
Managerial processes	95.51%	96.08%	96.74%	93.03%	98.26%

TABLE II-B
COSTS AND SCHEDULES OF PROJECTS EXECUTED WITH THE IMS SYSTEM

	PROJECTS MANAGED WITH A MANAGEMENT SYSTEM				
TYPE	TM	BC	IKRO	NV	RPK
Initial cost	$ 7,079,160.00	$ 2,432,448.00	$ 9,415,878.00	$ 14,635,374.00	$ 5,432,442.00
Final cost	$ 7,212,956.12	$ 2,428,920.95	$ 9,479,905.97	$ 14,857,831.68	$ 5,446,566.35
Cost variation	1.89%	-0.15%	0.68%	1.52%	0.26%
Initial time	$ 365.00	$ 240.00	$ 380.00	$ 540.00	$ 269.00
Final time	$ 391.00	$ 245.00	$ 421.00	$ 558.00	$ 284.00
Time variation	7.12%	2.08%	10.79%	3.33%	5.58%
Management system	SÍ	SÍ	SÍ	SÍ	SÍ
Estimated management cost	4.00%	4.00%	4.00%	4.00%	4.00%
Management processes	93.25%	97.75%	96.25%	93.75%	97.00%
Strategic processes	98.00%	99.00%	98.50%	95.00%	97.50%
Managerial processes	97.22%	96.16%	97.30%	96.00%	98.80%

TABLE III - A
COMPARISON OF HIGHER AND LOWER COSTS BY TECHNICAL SPECIALTY

		MOSAIQ	DLH	HDP	HPARDO	IG
Higher Costs in Dollars	Structural Works	$ 12,487.00	$ -	$ 236,895.00	$ 166,732.51	$ -
	Architecture	$ 78,489.00	$ 10,458.00	$ 120,586.00	$ 19,140.85	$ 25,879.54
	IISS	$ 5,489.74	$ 25,831.00	$ 31,589.57	$ 86,610.08	$ -
	IIEE	$ -	$ 308,436.56	$ 15,741.23	$ 79,137.99	$ -
	IIMM	$ -	$ -	$ -		$ -
	Others	$ 2,547.00	$1,141,896.81	$ 147,896.75	$ 489.17	$ 5,307.43
Higher Costs as Percentage	Structural Works	0.156%	0.000%	0.672%	1.217%	0.000%
	Architecture	0.979%	0.039%	0.342%	0.140%	0.366%
	IISS	0.069%	0.097%	0.090%	0.632%	0.000%
	IIEE	0.000%	1.164%	0.045%	0.578%	0.000%
	IIMM	0.000%	0.000%	0.000%	0.000%	0.000%
	Others	0.032%	4.310%	0.419%	0.004%	0.075%
			Lower Costs			
Dollars Lower Costs in	Structural Works	$ -	$ -256,789.24	$ -2,658.56	$ -6,901.67	$ -1,598.75
	Architecture	$ -	$ -	$ -1,356.52	$ -25,972.23	$ -14,753.69
	IISS	$ -	$ -	$ -	$ -44,569.18	$ -
	IIEE	$ -	$-1,456,852.56	$ -	$ -388,608.39	$ -
	IIMM	$ -	$ -	$ -		$ -
	Others	$ -5,635.72	$ -11,569.41	$ -10,321.86	$ -	$ -
Lower Costs as Percentage	Structural Works	0.000%	-0.969%	-0.008%	-0.050%	-0.023%
	Architecture	0.000%	0.000%	-0.004%	-0.190%	-0.209%
	IISS	0.000%	0.000%	0.000%	-0.325%	0.000%
	IIEE	0.000%	-5.499%	0.000%	-2.837%	0.000%
	IIMM	0.000%	0.000%	0.000%	0.000%	0.000%
	Others	-0.070%	-0.044%	-0.029%	0.000%	0.000%
			Results			
Total Higher Costs as Percentage		1.165%	-0.901%	1.526%	-0.832%	0.210%

the objective of obtaining accurate information regarding the direct costs of the building projects analysed.

Technique: The survey was selected as the primary technique due to its direct nature, accessibility, and ability to efficiently gather structured information. According to Hernández-Ramos and Placencia (2018, p. 117), surveys are among the most common procedures in applied research, particularly in organizational contexts where it is necessary to obtain specific data from the actors involved. Instrument: The instrument used was a structured questionnaire composed of a set of questions designed to measure variables related to construction costs. As noted by Ríos (2017, p. 104), questionnaires facilitate the systematic collection of quantifiable data, enabling subsequent statistical analysis. The design of the questionnaire was aligned with the objectives of the study and was administered to the technical personnel responsible for the selected projects, ensuring the validity of the information obtained and its relevance for the comparative analysis between projects.

E. Evidence

The quantitative evidence obtained during the research is presented through a set of tables developed from real data collected in the projects analyzed (Tables 1, 2, 3, and 4). These elements provide a clear and comparative visualization of the impact of the Integrated Management System (IMS) on key cost and schedule indicators.

III. RESULTS AND DISCUSSION

A. Project Costs

1) Projects managed without a management system

The analysis shows that the average percentage of cost overruns is 8.82%, which indicates that the projects under review incurred significant additional costs, directly affecting overall project profitability (Fig. 1).

These cost overruns occurred because, in the absence of a management system, the scope of work became subject to frequent disputes that resulted in requests for additional payments. On the client's side, there were no formats, records, or documents capable of demonstrating the originally

TABLE IV
PERCENTAGE OF COMPLIANCE WITH STRATEGIC AND MANAGERIAL PROCESSES PER PROJECT

	MSQ	DLI	HDCPS	HEPM	TM	BC	ÍCARO	NUVÓ	RPK	IGLESIAS
Management Processes										
Allocation of budgets for the implementation of guidelines and policies	92.00%	96.00%	92.00%	100.00%	90.00%	100.00%	100.00%	95.00%	100.00%	95.00%
Defining quality guidelines and policies	95.00%	98.00%	95.00%	99.00%	98.00%	98.00%	95.00%	95.00%	95.00%	98.00%
Defining occupational health and safety guidelines and policies	89.00%	97.00%	94.00%	98.00%	90.00%	98.00%	100.00%	90.00%	98.00%	95.00%
Defining environmental care guidelines and policies	94.00%	98.00%	90.00%	99.00%	95.00%	95.00%	90.00%	95.00%	95.00%	92.00%
Compliance percentage (%)	**92.50%**	**97.25%**	**92.75%**	**99.00%**	**93.25%**	**97.75%**	**96.25%**	**93.75%**	**97.00%**	**95.00%**
Strategic Processes										
Establish teams for the monitoring and control of the integrated management system	80.00%	90.00%	98.00%	95.00%	99.00%	100.00%	100.00%	95.00%	98.00%	100.00%
Set objectives and verify their compliance	95.00%	92.00%	96.00%	80.00%	97.00%	98.00%	97.00%	95.00%	97.00%	95.00%
Compliance percentage (%)	**87.50%**	**91.00%**	**97.00%**	**87.50%**	**98.00%**	**99.00%**	**98.50%**	**95.00%**	**97.50%**	**97.50%**
Managerial Processes										
1. Initial Activities		95.00%	100.00%	100.00%	95.00%	100.00%	100.00%	100.00%	100.00%	100.00%
1.1 Requirement Management	95.00%	91.00%	90.00%	98.00%	95.00%	90.00%	100.00%	100.00%	100.00%	100.00%
Initial meeting with the client	80.00%	88.00%	85.00%	95.00%	95.00%	90.00%	100.00%	100.00%	100.00%	100.00%
List of documents delivered by the client	100.00%	100.00%	70.00%	80.00%	90.00%	90.00%	90.00%	100.00%	100.00%	100.00%
1.2 Scope Management	94.00%	100.00%	98.00%	90.00%	98.00%	100.00%	95.00%	100.00%	100.00%	100.00%
Definition of project scope	98.00%	100.00%	95.00%	90.00%	98.00%	100.00%	95.00%	100.00%	100.00%	100.00%
Definition of work teams	90.00%	100.00%	90.00%	90.00%	98.00%	100.00%	95.00%	100.00%	100.00%	100.00%
1.3 Agreements and commitments	90.00%	100.00%	90.00%	100.00%	95.00%	100.00%	90.00%	100.00%	100.00%	100.00%
Meeting with the client	90.00%	100.00%	90.00%	100.00%	95.00%	100.00%	90.00%	100.00%	100.00%	100.00%
1.4 Evaluation and Estimates	100.00%	100.00%	95.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Feasibility study	100.00%	0.00%	95.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Commercial feasibility	90.00%	0.00%	50.00%	0.00%	80.00%	100.00%	80.00%	100.00%	100.00%	100.00%
Legal feasibility	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Technical feasibility	100.00%	100.00%	96.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Organizational feasibility	90.00%	90.00%	80.00%	100.00%	50.00%	100.00%	80.00%	100.00%	100.00%	100.00%
Financial feasibility	100.00%	95.00%	75.00%	0.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Planning	100.00%	98.00%	100.00%	100.00%	95.00%	100.00%	98.00%	100.00%	100.00%	100.00%
Financial estimation of the project using ratios	100.00%	95.00%	100.00%	0.00%	100.00%	100.00%	90.00%	90.00%	100.00%	100.00%
1.5 Project Start	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%	90.00%	100.00%	100.00%
Preparation of the project start act	80.00%	100.00%	100.00%	95.00%	90.00%	100.00%	100.00%	90.00%	100.00%	100.00%
2. Preliminary Design	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Urban analysis	0.00%	98.00%	98.00%	0.00%	100.00%	0.00%	0.00%	100.00%	100.00%	0.00%
Site visit	90.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Adaptation of the project to urban planning parameters	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Management of preliminary studies	100.00%	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%	100.00%	100.00%
Preparation of the list of contractual documents	80.00%	100.00%	100.00%	90.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Preliminary design management	100.00%	100.00%	100.00%	100.00%	98.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Consolidation of the preliminary design for presentation	90.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Meeting for project constitution	95.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%
Management of licenses and permits	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%

3. Project	100.00%	98.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Management of the technical file (compliance with operational processes)	81.77%	90.34%	100.00%	100.00%	85.00%	100.00%	100.00%	80.00%	90.00%	88.00%
Definition of bidding packages	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Bidding process for the development of the technical file	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%
Invitation letter to bidders	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Sworn confidentiality statement	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	85.00%	100.00%	100.00%
Preparation of the terms and conditions document	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	85.00%	100.00%	100.00%
Information provided to bidders	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	95.00%	100.00%	100.00%
Site visit report	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Bidders' inquiries	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Responses to inquiries	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Proposal submitted by bidders	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Approved budget	100.00%	100.00%	100.00%	100.00%	80.00%	100.00%	100.00%	90.00%	100.00%	100.00%
Award letter	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Signed contract and annexes	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%	100.00%	100.00%	100.00%
4. Construction	100.00%	97.50%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Preparation of construction start documents	100.00%	100.00%	100.00%	85.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%
Coordination meetings	100.00%	100.00%	100.00%	80.00%	100.00%	100.00%	100.00%	90.00%	100.00%	95.00%
Construction progress control	100.00%	100.00%	100.00%	98.00%	100.00%	100.00%	100.00%	98.00%	100.00%	100.00%
Reports and documentation	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%
Technical supervision of the construction	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	95.00%	100.00%	100.00%
Change control	100.00%	90.00%	100.00%	100.00%	100.00%	100.00%	100.00%	98.00%	100.00%	100.00%
Contract management	100.00%	90.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Record of entries in construction logbooks	100.00%	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	90.00%	100.00%	100.00%
Control of construction drawings	100.00%	100.00%	90.00%	100.00%	100.00%	95.00%	100.00%	90.00%	100.00%	100.00%
Construction valuations control	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	98.00%	100.00%	100.00%
Control of letters of guarantee and insurance	96.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	80.00%	100.00%
Budget control (higher and lower costs)	100.00%	98.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	98.00%	100.00%
Schedule control	85.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	90.00%	90.00%	100.00%
Control of documents received/sent	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	90.00%	90.00%	100.00%
Monitoring of safety and environmental impact	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%	100.00%	85.00%	80.00%	100.00%
Information requirements	100.00%	100.00%	100.00%	100.00%	100.00%	80.00%	100.00%	90.00%	85.00%	100.00%
Preparation of the quality dossier	80.00%	100.00%	100.00%	100.00%	100.00%	95.00%	100.00%	100.00%	100.00%	100.00%
5.- Closeout	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Preparation of the construction acceptance report with observations	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%	90.00%	100.00%	100.00%
Review of as-built drawings	90.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%
Review and consolidation of the quality dossier	100.00%	100.00%	80.00%	100.00%	100.00%	100.00%	100.00%	85.00%	100.00%	90.00%
Preparation of the settlement and closeout of construction contracts	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	98.00%	100.00%	100.00%
Management for the submission of project documents	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	95.00%	100.00%	100.00%
Preparation of the construction acceptance report without observations	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%	98.00%	100.00%	100.00%
Administrative closeout of the project	97.00%	100.00%	95.00%	100.00%	100.00%	100.00%	100.00%	90.00%	100.00%	100.00%
Preparation of the final report	95.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Project handover	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Compliance percentage (%)	**95.51%**	**96.08%**	**96.74%**	**93.03%**	**97.22%**	**96.16%**	**97.30%**	**96.10%**	**98.81%**	**98.26%**

contracted scope, which could have helped prevent unjustified cost and schedule increases. The formats and records that would normally allow clear definition and control of scope, time, cost, quality, safety, and environmental management were either nonexistent or extremely limited in these projects without a management system.

This pattern is consistent with the findings of Tinoco (2020), who demonstrated that the absence of formal records in procurement and contracting processes creates difficulties in validating contractual obligations, thereby increasing the likelihood of uncontrolled cost overruns. Similarly, Baltazar (2022) highlights that the lack of documentary traceability in projects without a structured management framework increases technical and contractual disputes during the execution phase.

2) Works managed with a management system

These projects show an average cost increase of 0.54%, mainly due to scope changes that were properly controlled, thus preventing significant cost overruns. Projects with negative percentages indicate that they were completed below the contracted cost, primarily because scope modifications were managed efficiently (Fig. 2).

3) Projects managed with a management system, including management costs:

If we consider that the cost of project management services represents, on average, 4% of the total construction cost, we find that the average total increase—including both the cost overruns and the cost of hiring a project management team—

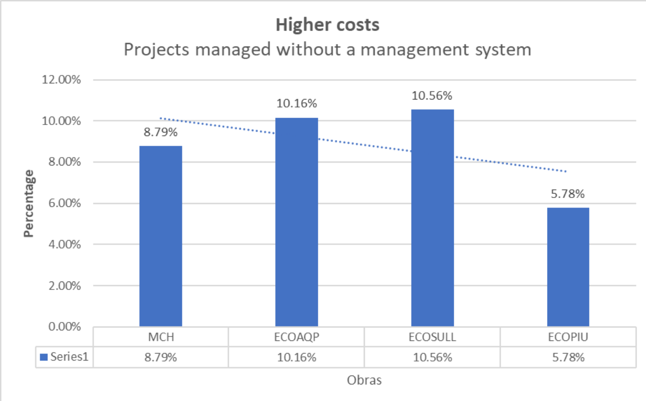

Fig. 1. Higher costs in projects managed without a management system

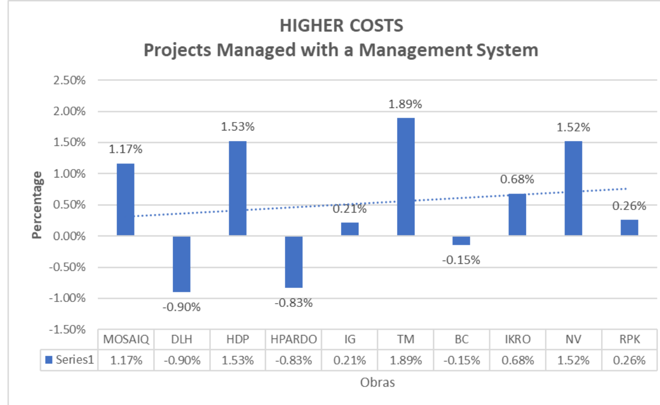

Fig. 2. Higher costs in projects executed with a management system

amounts to 4.54%. This value remains significantly lower than the 8.82% cost overruns observed in projects managed without a management system (Fig. 3).

4) Higher costs by technical specialty in projects managed without and with a management system

Fig. 4 presents the average cost overruns by technical specialty in construction projects, comparing cases with and without a management system. The key findings are summarized below:

- Structural Works and Architecture: Without a management system, additional costs are significantly high (2.575% and 3.133%, respectively). With the management system, these costs decrease substantially to 0.266% and 0.273%.
- Sanitary Installations (IISS): A notable reduction is also observed, from 0.966% without the system to 0.069% with the system.
- Electrical Installations (IIEE): This is the only category where a negative saving (–0.577%) is recorded with the system, compared to 1.212% without the system.
- Mechanical Installations (IIMM): No significant changes are observed.
- Others: A moderate reduction is recorded, from 0.662% to 0.506%..

These results suggest that the management system has a positive impact on reducing additional costs across most technical specialties, particularly in higher-cost areas such as Structural Works and Architecture.

5) Average higher costs, including management costs

This graph shows the average cost overruns in construction projects, comparing those managed without a management system (8.82%) to those managed with a management system (4.54%), including the cost of management. This reflects a significant reduction in the average cost when a management system is implemented—representing a decrease of more than 48% (Fig. 5).

The inclusion of a management system effectively reduces additional costs, suggesting its effectiveness in optimizing project economics. This finding strengthens the argument regarding the benefits of an integrated management system in terms of cost savings within the context of building projects.

6) Average higher costs

Fig. 6 shows the average cost overruns in projects managed with and without a management system.

Projects without a management system: Additional costs represent 8.82%. Projects with a management system: Cost overruns amount to 0.54%, representing a drastic reduction compared to the 8.82% observed in unmanaged projects.

This result further highlights the efficiency of implementing a management system in reducing cost overruns, achieving a substantial improvement that approaches an almost complete elimination of additional costs.

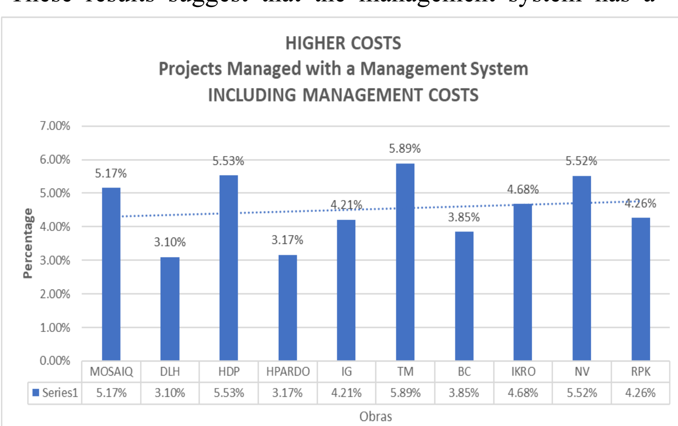

Fig. 3. Higher costs of projects managed with a management system, including management costs

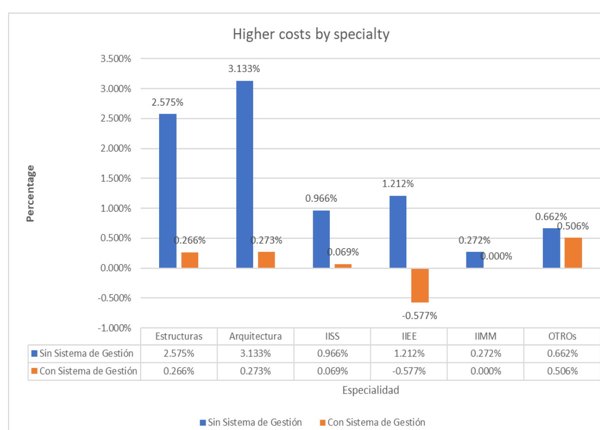

Fig. 4. Higher costs by specialty in projects managed with a management system, including management costs.

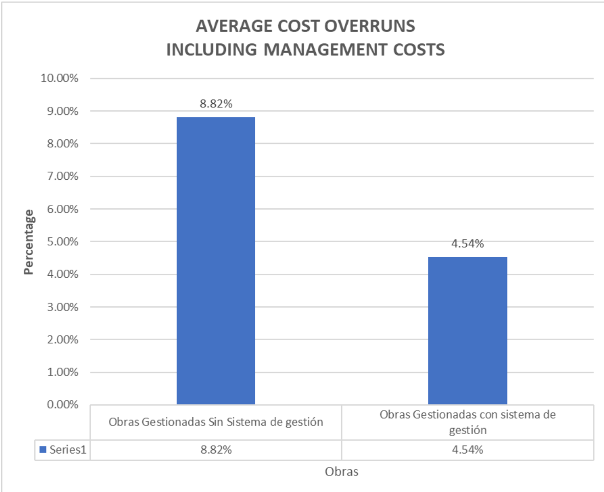

Fig. 5. Comparison of cost overrun percentages in projects executed without a management system and projects executed with a management system (including management costs).

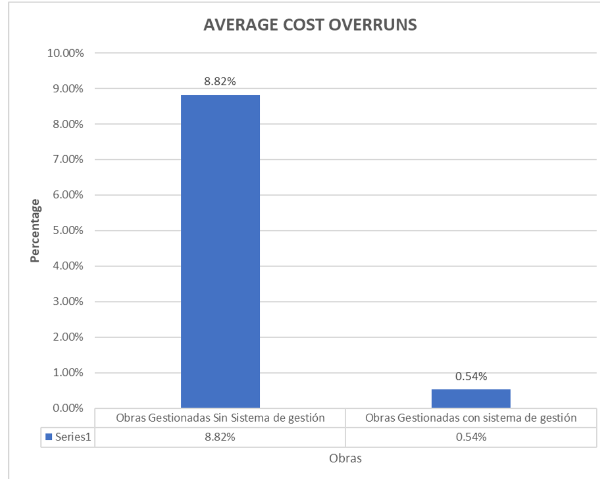

Fig. 6. Comparison of cost overrun percentages in projects executed without a management system and projects executed with a management system (excluding management costs)

B. *Project Schedule Performance*

1) *Execution time of projects without a management system*

The graph presents the additional execution times in various projects (MCH, ECOAQP, ECOSULL, and ECOPIU) that were managed without a management system. ECOAQP shows the highest increase, with 25.83%, followed by MCH with 14.29%, while ECOSULL and ECOPIU exhibit smaller increases of 12.02% and 10.00%, respectively (Fig. 7).

These results highlight the importance of implementing a management system to improve control over execution times and provide a basis for comparison with projects that do employ such a system.

2) *Execution time of projects with a management system*

The graph illustrates the additional time recorded in various projects managed with a management system, showing the percentage of schedule overruns in each case. The MOSAIQ project presents the highest increase in execution time (13.33%), followed by HPARDO (12.02%) and IKRO (10.79%). In contrast, the projects with the lowest time increases are BC (2.08%) and HDP (4.11%).

The trend line indicates an overall reduction in additional time, suggesting a decrease in the variability of delays when a management system is applied, although significant differences between projects are still observed (Fig. 8). This analysis contributes to evaluating the effectiveness of the system in controlling execution times across different project contexts.

3) *Average execution time of projects*

The graph compares the average additional execution time in projects managed without and with a management system. Projects without a management system show a higher average additional time of 15.54%, whereas those that employ a management system present a significantly lower average of 7.14% (Fig. 9). This difference suggests that the use of a management system contributes to reducing delays, thereby optimizing execution time in building projects.

C. *Compliance with the Management System*

1) *Average compliance with the management system by process*

The graph shows the average level of compliance in the use of the management system across different processes in construction projects. Managerial processes exhibit the highest level of compliance (96.51%), followed by directional processes (95.45%) and strategic processes (94.85%). In terms of performance, the average cost overrun remains low at 0.54%, while the average time overrun is 7.14% (Fig. 10).

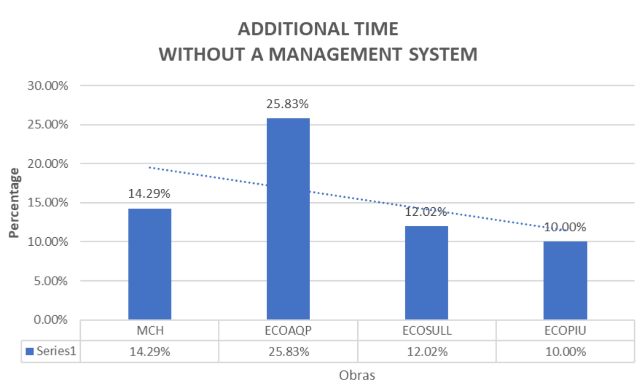

Fig. 7. Additional execution time in projects managed without a management system.

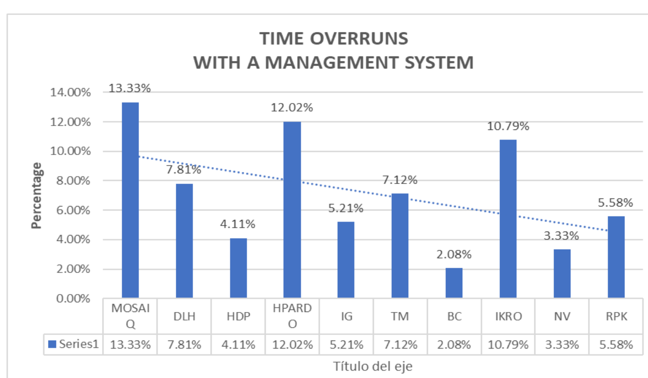

Fig. 8. Additional execution time in projects managed with a management system.

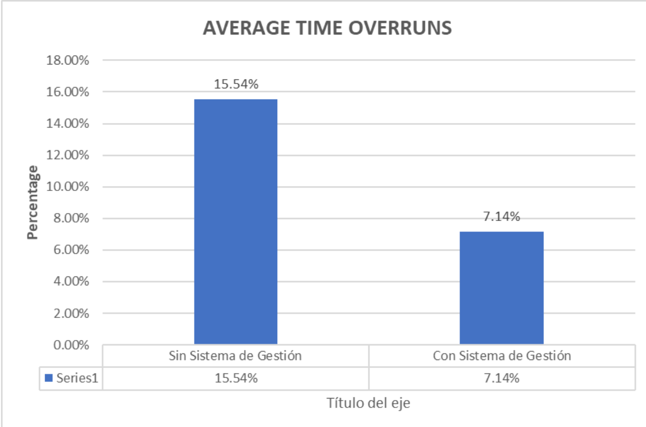

Fig. 9. Comparison of additional execution time in projects managed without a management system and with a management system.

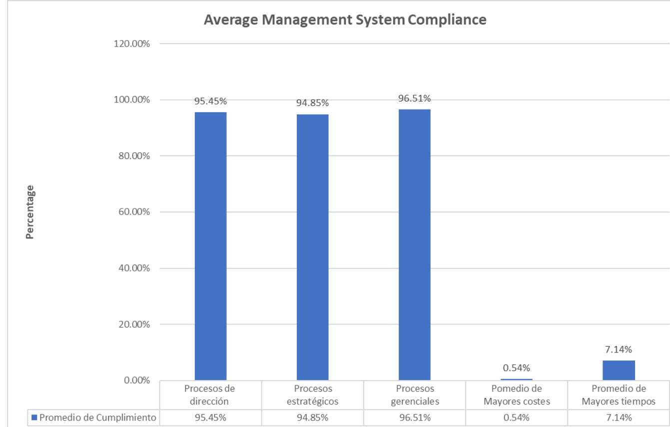

Fig. 10. Average compliance with management system processes and higher costs obtained.

These results indicate a high level of compliance in the key processes of the management system, which is reflected in the significant reduction of both cost overruns and additional execution time in the projects.

2) Compliance with the Integrated Management System by project

Fig. 11 shows the relationship between the average compliance level of the Integrated Management System (IMS), cost overruns, and time overruns across different projects. Compliance with the IMS is high in all cases, exceeding 90% in every project, with a maximum of 97.77% in RPK. Cost overruns and additional execution time show some variation but generally remain low. Cost overruns range from negative values (cost reductions) to small increases, while time overruns vary more, with peaks such as MOSAIQ (13.33%) and IKRO (10.78%).

The trend line illustrates that higher IMS compliance is associated with lower cost overruns and reduced additional execution time, highlighting the effectiveness of the IMS in optimizing these performance indicators.

A notable observation is that compliance with the management system appears to have a more substantial impact on cost reduction than on time reduction. This suggests that the system may prioritize cost optimization over schedule optimization.

It is also observed that some projects present negative cost overruns (cost savings of –0.901%) and small positive overruns (1.89%). In contrast, projects without a management system exhibit significantly higher average cost overruns of 8.82%, as shown in Fig. 11.

IV. DISCUSSION AND INTERPRETATIVE SYNTHESIS

1) Average compliance with the management system by processes

The results of this research confirm that the implementation of the Integrated Management System (IMS) contributes effectively to the optimization of costs and schedules in building projects. The comparative analyses conducted between projects executed with and without the system show substantial improvements in resource management, procurement control, and activity scheduling, demonstrating the effectiveness of the proposed model.

The findings reaffirm the benefits of implementing structured management systems as tools to mitigate cost and schedule deviations. This aligns with the conclusions of Uguña (2019), who documented significant improvements in traceability and efficiency following the adoption of the Procore software in building projects. Similarly, Llanque (2021) found that the application of BIM technology optimizes budget estimation and facilitates the management of physical–financial progress, thereby reducing financial and administrative risks.

The reduction of cost overruns in the projects analyzed confirms that the IMS helps reduce additional costs generated by poor planning and deficient control of construction processes. In the projects where the system was applied, the results show a notable decrease in direct cost deviations compared to the initial projected values. This effect is directly related to improved control over procurement schedules, supplier homologation, and the timely availability of materials—elements that displayed recurrent deficiencies in projects without a management system.

Regarding execution time, the results demonstrate that the IMS positively influences the reduction of delays and supports adherence to the established schedule. Projects that implemented the system presented better schedule performance, indicating stricter control over critical activities and more efficient management of material and human resource flows. This supports the initial hypothesis that coordinated planning and systematic monitoring help mitigate the most frequent causes of delay in building projects.

Furthermore, the high level of IMS compliance achieved across projects validates the applicability of the system within the Peruvian context. This level of compliance reflects the acceptance of the model by technical teams and its effectiveness as a practical tool that enhances communication, process traceability, and decision-making efficiency.

The findings also highlight the importance of integrating processes in construction management. Whereas traditional systems treat procurement, scheduling, and construction control as separate areas, the proposed IMS integrates these functions within a unified and structured framework, enabling timely and reliable information for management. This integration

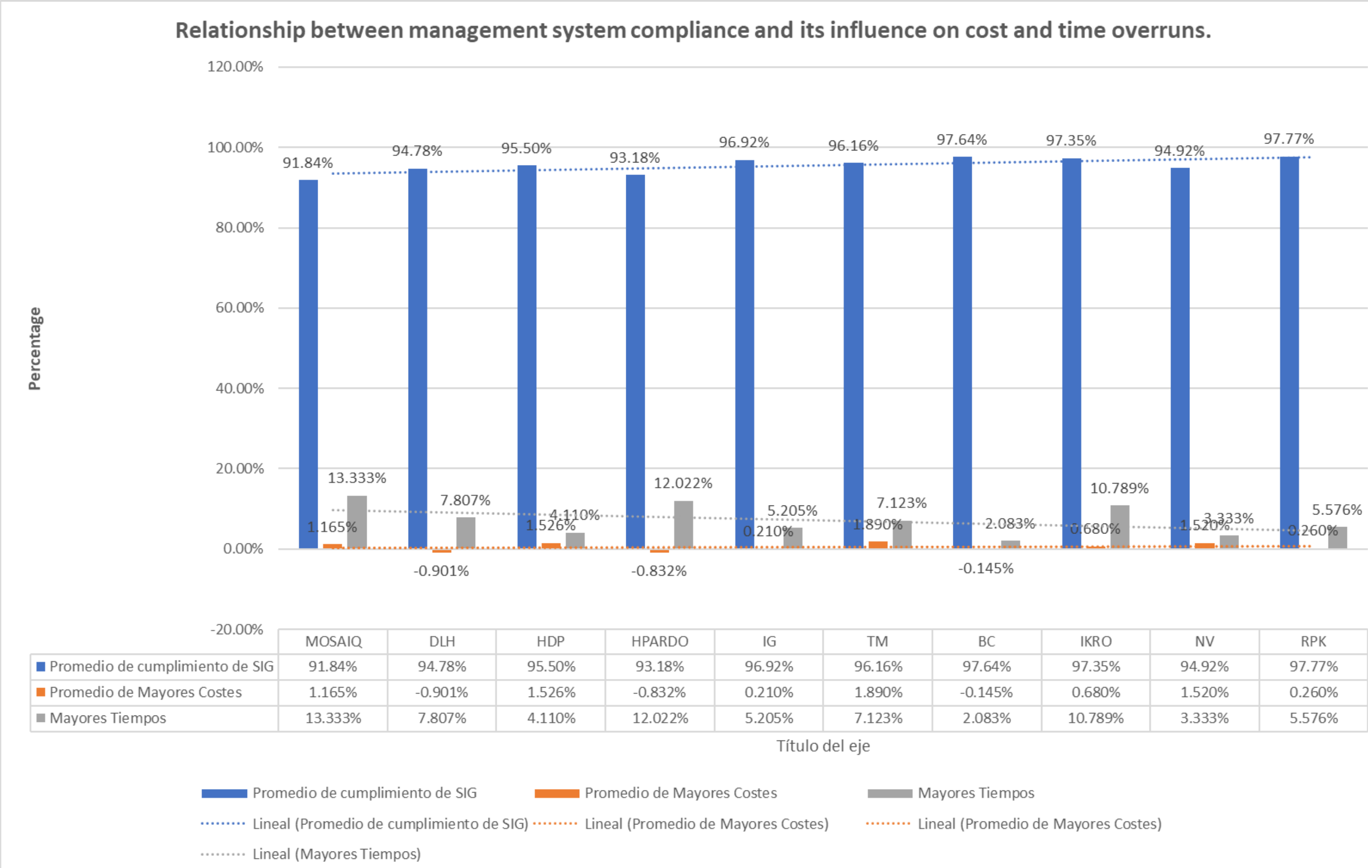

Fig. 11. Relationship between management system compliance and its influence on cost and time overruns.

facilitates early detection of deviations and supports the implementation of corrective actions before impacts translate into significant cost overruns or delays.

The research also demonstrates that the success of the system depends on the commitment and training of the technical personnel involved. In cases where the team rigorously applied the defined procedures, the results were more consistent. Conversely, in projects with lower levels of system compliance, improvements were less evident, highlighting the need to strengthen organizational culture around process-based management.

Finally, the results confirm that the Integrated Management System represents a viable and adaptable alternative for building projects in moderately complex contexts such as Peru. Its implementation does not require substantial technological investment, as it is based on standardized procedures and accessible tools, facilitating replication in small and medium-sized construction firms. Nevertheless, expanding the sample to include projects of different types—such as commercial or industrial buildings—and incorporating advanced digital technologies (BIM, collaborative platforms) should be considered for future research to strengthen and expand the scope of the proposed model.

V. CONCLUSIONS

Based on the analysis conducted in this research, it is concluded that the implementation of the proposed Integrated Management System (IMS) has a significant positive effect on optimizing costs and execution times in urban building projects within the Peruvian context. The system enabled the structuring, standardization, and systematization of key processes related to procurement management, construction scheduling, and resource control, contributing to more efficient and controlled execution.

Projects that applied the IMS showed a reduction in average cost overruns from 8.82% to 0.54%, representing an improvement of more than 90%. Even when considering the management cost, the savings remain substantial (4.54%), demonstrating that the system not only reduces cost overruns but does so efficiently and sustainably. The study confirmed that the major cost overruns—typically associated with poor procurement planning, low inventory rotation, and inefficient material acquisition—can be significantly mitigated through the use of the system. This is reflected in improved procurement traceability, timely supply scheduling, and reduced rework.

Regarding schedule performance, projects with the IMS showed a reduction in average delays from 15.54% to 7.14%, confirming that the system contributes to more controlled and predictable execution. Although the impact on schedule is less uniform than on cost, a clear trend toward improvement in scheduling and schedule compliance was observed. The research validated that projects lacking an IMS displayed higher incidences of inter-area miscoordination, lack of updated information, and reactive decision-making, all of which contribute to cost overruns and delays.

The proposed IMS has proven to be viable and replicable in similar contexts, especially in medium-sized construction firms operating in Peruvian urban environments. Its implementation, based on practical tools such as supplier records, supply schedules, and standardized control formats, does not require significant technological investment, facilitating its adoption.

In conclusion, the findings of this study confirm the usefulness of the IMS as a strategic control tool for building projects. The results support the initial hypothesis and open opportunities for future research aimed at expanding its application to other types of projects and integrating complementary technologies such as BIM or collaborative platforms.

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