[I] INTRA Interdisciplinary Research and Analysis Journal

Volume 2, Issue 1, 2025

Analysis of Organizational Factors and Performance in BIM Projects: Empirical Evidence from the Latin American Construction Industry

Christian Zambrano [1], Estuardo Paredes [2], Milton Zambrano [3] and Diego Castro [4]

[1] Universidad Laica Vicente Rocafuerte; ORCID 0000-0002-6743-0342; czambranomur@ulvr.edu.ec
[2] Universidad Bolivariana del Ecuador; ORCID 0009-0000-0831-6817; evparedesc@ube.edu.ec
[3] Universidad Bolivariana del Ecuador; ORCID 0000-0001-7955-7984; mozambranoc@ube.edu.ec
[4] Universidad Bolivariana del Ecuador; ORCID 0009-0007-1361-6727; dhcastroh@ube.edu.ec

***Abstract*—** Efficient management of construction projects using Building Information Modeling (BIM) technologies is crucial to optimizing resources, reducing delays, and improving quality in the AEC industry. This study analyzed associations between organizational variables (work area, BIM software used, type of company, level of experience) and key performance indicators (delays, costs, satisfaction) based on a sample of 101 Latin American professionals. Both descriptive techniques and inferential tests were applied—such as contingency tables, Chi-square, normality tests, Wilcoxon, and ANOVA—according to the nature of each variable. The main results showed that only the relationship between company type and experience level was statistically significant, with independent firms presenting lower BIM experience than consultancies and clients (Succar et al., 2022). No significant associations were found between functional area or BIM software and either the frequency of delays or professional satisfaction, in line with studies that highlight management and training as key determinants (Eastman et al., 2018; Gu & London, 2010). Quantitative variables displayed non-normal distributions, with strong asymmetry and the presence of outliers, underscoring the need for non-parametric methods and a focus on problematic projects. Furthermore, lower levels of experience were found to be associated with higher delays, emphasizing the importance of continuous training (Barbosa et al., 2017). The study concludes that digital maturity and organizational experience are the most relevant factors for success in BIM projects, suggesting that policies and training programs should target less-experienced actors and reinforce the use of robust statistics for performance monitoring in the construction industry (Chong et al., 2017; Martínez-Rojas et al., 2016).

Keywords: Building Information Modeling, project management, delays, professional experience, organizational variables, professional satisfaction

INTRODUCTION

Efficient project management in the construction industry today demands the integration of methodologies and tools that allow for resource optimization, minimize delays, and increase standards of quality and competitiveness. In this context, Building Information Modeling (BIM) has emerged as a pillar of the sector's digital transformation, revolutionizing processes through collaboration, three-dimensional modeling, and comprehensive data management. Nevertheless, the adoption and performance of BIM are conditioned by organizational, technological, and human factors, which can result in delays, additional costs, or inconsistencies in job satisfaction among professionals involved. International evidence has shown that variables such as area of expertise (design, execution, supervision), BIM software used, company type, and level of professional experience can be associated with different levels of efficiency and success in BIM project implementation. However, these factors have mainly been studied in developed countries, leaving a significant gap in Latin American contexts, where digital integration faces unique challenges arising from technological maturity, resource availability, and diverse organizational practices. Based on this premise, the present study aims to determine the existence of significant associations between organizational variables (work area, software, company type, experience) and the main performance indicators (delays, costs, satisfaction) in projects managed under the BIM methodology. Through the application of advanced statistical inference techniques adapted to the nature of the data, the goal is to provide evidence to support strategic decision-making in the sector and contribute to the scientific literature on management and digitization in construction. The relevance of this work lies in offering a contextualized empirical analysis that reveals critical patterns and relationships to guide training programs, process improvement, and organizational policies, contributing both to academic advancement and professional enhancement in the industry. Thus, this article connects statistical and methodological rigor with the practical challenges inherent to the digital transformation of the construction sector in Latin America and other similar development scenarios.

MATERIALS AND METHODS

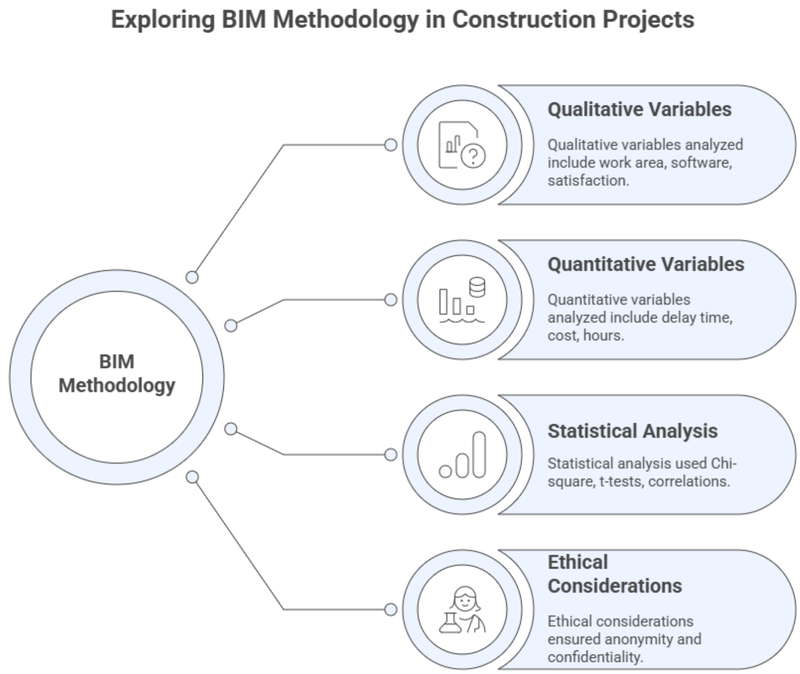
Methodology

a. Study design

A cross-sectional study of a descriptive and inferential nature was conducted, using a sample of 101 professionals participating in design and construction projects using BIM methodology. Selection was based on accessibility, integrating experts from various areas (design, execution, supervision) and companies (construction firms, consultancies, clients, independents).

Qualitative variables (work area, BIM software used, company type, level of BIM experience, satisfaction) and quantitative variables (average project delay time, average additional cost because of delays in dollars, average weekly hours dedicated to BIM coordination) were analyzed, reported through a structured survey.

Contingency tables and Chi-square tests were constructed to detect associations between qualitative variables. Normality of continuous variables was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive statistics (mean, median, skewness, kurtosis) were presented. One-sample t-test or Wilcoxon signed-rank test (if non-normality) were used to compare performance variables to hypothetical values. Associations between quantitative variables were measured using Pearson or Spearman correlation as appropriate. Wilcoxon test was applied for paired measurements and ANOVA/Kruskal-Wallis to compare differences between experience groups. All analysis was performed using computational statistics (SPSS, R or similar). A significance level of $\alpha=0.05$ was adopted. Anonymity and confidentiality of participants were maintained, complying with ethical criteria.



RESULTS

The analysis of results in this study focuses on understanding the complex interplay between organizational variables and project performance indicators in BIM-managed construction projects across Latin America. By utilizing both descriptive and inferential statistical methods, including contingency tables, Chi-square tests, normality assessments, and non-parametric analyses, the study provides a detailed empirical foundation to evaluate how factors such as work area, BIM software utilized, company type, and experience level impact core metrics such as delays, additional costs, and professional satisfaction.

The data set comprises responses from 101 professionals active in design, execution, and supervision roles, drawn from a diverse array of organizations including construction firms, consultancies, clients, and independent practitioners. The results demonstrate pronounced heterogeneity in both qualitative and quantitative variables, with some categories—such as software choice—strongly dominated by Revit (used by over 80% of respondents), potentially influencing the ability to detect significant associations among alternatives. Notably, quantitative indicators such as average project delay time, extra costs generated by delays, and weekly hours dedicated to BIM coordination all exhibit non-normal, right-skewed distributions with distinct kurtosis, indicating the presence of atypically problematic projects that disproportionately influence overall averages.

Importantly, hypothesis testing reveals that average delay times in BIM projects are significantly lower than the hypothetical five-day benchmark, confirming a trend toward schedule improvement in digitally modeled projects. However, no substantial correlations were observed between hours of coordination and delay frequency, suggesting that intensive oversight alone does not necessarily guarantee enhanced outcomes. These findings highlight the multifactorial nature of performance results in BIM-driven environments.

Taken together, the results underscore that only the association between company type and BIM experience level reaches statistical significance, while other organizational variables—including work area and principal BIM software—notably fail to predict delays or professional satisfaction. This supports international evidence suggesting that management quality and digital maturity, rather than technical tools or organizational roles per se, are the critical determinants of success in construction projects utilizing BIM methodologies.

Associations between qualitative variables

a. Work area vs. frequency of delays

A contingency table was constructed, and the Chi-square test was applied to analyze the possible association between work area (Design, Execution, Supervision) and the frequency of delays in BIM model delivery. The analysis showed no statistically significant association ($\chi^2=2.064$, $df=6$, $p=0.914$). Work area does not determine the frequency of delays in this data set, although in the Design area, responses of "Never" and "Rarely" predominate, and there were no cases of "Always" in Execution.

Table 1 Work area vs. frequency of delays

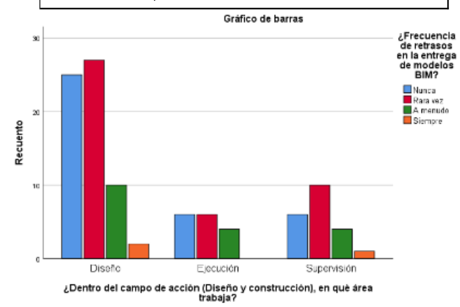
Área de trabajo vs. frecuencia de retrasos

			¿Frecuencia de retrasos en la entrega de				Total
			Nunca	Rara vez	A menudo	Siempre	
¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja?	Diseño	Recuento	25.00	27.00	10.00	2.00	64.00
		Recuento esperado	23.40	27.20	11.40	1.90	64.00
		% dentro de ¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja?	39.10%	42.20%	15.60%	3.10%	100.00%
		% dentro de ¿Frecuencia de retrasos en la entrega de modelos BIM?	67.60%	62.80%	55.60%	66.70%	63.40%
		% del total	24.80%	26.70%	9.90%	2.00%	63.40%
	Ejecución	Recuento	6.00	6.00	4.00	-	16.00
		Recuento esperado	5.90	6.80	2.90	0.50	16.00
		% dentro de ¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja?	37.50%	37.50%	25.00%	0.00%	100.00%
		% dentro de ¿Frecuencia de retrasos en la entrega de modelos BIM?	16.20%	14.00%	22.20%	0.00%	15.80%
		% del total	5.90%	5.90%	4.00%	0.00%	15.80%
	Supervisión	Recuento	6.00	10.00	4.00	1.00	21.00
		Recuento esperado	7.70	8.90	3.70	0.60	21.00
		% dentro de ¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja?	28.60%	47.60%	19.00%	4.80%	100.00%
		% dentro de ¿Frecuencia de retrasos en la entrega de modelos BIM?	16.20%	23.30%	22.20%	33.30%	21%
		% del total	5.90%	9.90%	4.00%	1.00%	20.80%
Total		Recuento	37.00	43.00	18.00	3.00	101.00
		Recuento esperado	37.00	43.00	18.00	3.00	101.00
		% dentro de ¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja?	36.60%	42.60%	17.80%	3.00%	100.00%
		% dentro de ¿Frecuencia de retrasos en la entrega de modelos BIM?	100.00%	100.00%	100.00%	100.00%	100.00%
		% del total	36.60%	42.60%	17.80%	3.00%	100.00%

Pruebas de chi-cuadrado

	Valor	df	Significación asintótica (bilateral)
Chi-cuadrado de Pearson	2.064[a]	6	0.914
Razón de verosimilitud	2.487	6	0.87
Asociación lineal por lineal	0.686	1	0.408
N de casos válidos	101		

a. 5 casillas (41.7%) han esperado un recuento menor que 5. El recuento mínimo esperado es .48.



b. Software used vs. level of satisfaction

It was examined whether the main BIM software (Revit, Archicad, Allplan, Others) is related to user satisfaction in BIM process management. The Chi-square test ($\chi^2=13.273$, $df=8$, $p=0.103$) indicates there is no significant association ($p>0.05$). The predominance of Revit (80.2%) may mask real differences; satisfaction is widely distributed among the main categories.

Table 2 Most used software vs. level of satisfaction in BIM processes

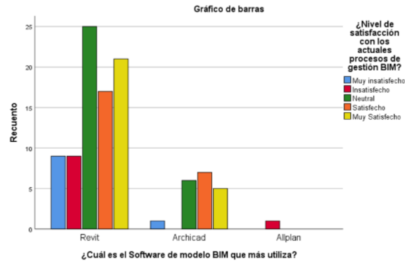
Software más utilizado vs. nivel de satisfacción en procesos BIM

¿Cuál es el Software de modelo BIM que más utiliza?		¿Nivel de satisfacción con los actuales procesos de gestión BIM? Muy insatisfecho	Insatisfecho	Neutral	Satisfecho	Muy Satisfecho	Total
Revit	Recuento	9	9	25	17	21	81
	Recuento esperado	8	8	24.9	19.2	20.9	81
	% dentro de ¿Cuál es el Software de modelo BIM que más utiliza?	11.10%	11.10%	30.90%	21.00%	25.90%	100.00%
	% dentro de ¿Nivel de satisfacción con los actuales procesos de gestión BIM?	90.00%	90.00%	80.60%	70.80%	80.80%	80.20%
	% del total	8.90%	8.90%	24.80%	16.80%	20.80%	80.20%
Archicad	Recuento	1	0	6	7	5	19
	Recuento esperado	1.9	1.9	5.8	4.5	4.9	19
	% dentro de ¿Cuál es el Software de modelo BIM que más utiliza?	5.30%	0.00%	31.60%	36.80%	26.30%	100.00%
	% dentro de ¿Nivel de satisfacción con los actuales procesos de gestión BIM?	10.00%	0.00%	19.40%	29.20%	19.20%	18.80%
	% del total	1.00%	0.00%	5.90%	6.90%	5.00%	18.80%
Allplan	Recuento	0	1	0	0	0	1
	Recuento esperado	0.1	0.1	0.3	0.2	0.3	1
	% dentro de ¿Cuál es el Software de modelo BIM que más utiliza?	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%
	% dentro de ¿Nivel de satisfacción con los actuales procesos de gestión BIM?	0.00%	10.00%	0.00%	0.00%	0.00%	1.00%
	% del total	0.00%	1.00%	0.00%	0.00%	0.00%	1.00%
Total	Recuento	10	10	31	24	26	101
	Recuento esperado	10	10	31	24	26	101
	% dentro de ¿Cuál es el Software de modelo BIM que más utiliza?	9.90%	9.90%	30.70%	23.80%	25.70%	100.00%
	% dentro de ¿Nivel de satisfacción con los actuales procesos de gestión BIM?	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	% del total	9.90%	9.90%	30.70%	23.80%	25.70%	100.00%

Pruebas de chi-cuadrado

	Valor	df	Significación asintótica (bilateral)
Chi-cuadrado de Pearson	13.273[a]	8	0.103
Razón de verosimilitud	10.568	8	0.227
Asociación lineal por lineal	0.403	1	0.525
N de casos válidos	101		

a. 9 casillas (60.0%) han esperado un recuento menor que 5. El



c. Type of company vs. level of experience in BIM.

Company type was cross tabulated with user experience level. This association was significant (chi²=18.012, df=6, p=0.006), with medium magnitude (Cramér's V ≈ 0.30). Independent companies concentrate on low BIM experience, while consultancies and clients show greater diversity. This finding suggests that company type influences the BIM experience of their teams.

Table 3 Type of company vs. level of experience in BIM.

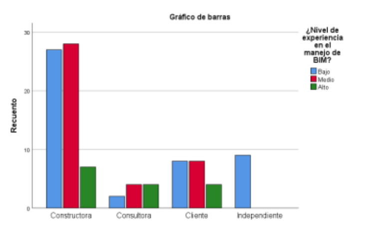
Tipo de empresa vs. nivel de experiencia en BIM

¿Tipo de empresa donde labora?		¿Nivel de experiencia en el manejo de BIM? Bajo	Medio	Alto	Total
Constructora	Recuento	27	28	7	62
	Recuento esperado	28.2	24.6	9.2	62
	% dentro de ¿Tipo de empresa donde labora?	43.50%	45.20%	11.30%	100.00%
	% dentro de ¿Nivel de experiencia en el manejo de BIM?	58.70%	70.00%	46.70%	61.40%
	% del total	26.70%	27.70%	6.90%	61.40%
Consultora	Recuento	2	4	4	10
	Recuento esperado	4.6	4	1.5	10
	% dentro de ¿Tipo de empresa donde labora?	20.00%	40.00%	40.00%	100.00%
	% dentro de ¿Nivel de experiencia en el manejo de BIM?	4.30%	10.00%	26.70%	9.90%
	% del total	2.00%	4.00%	4.00%	9.90%
Cliente	Recuento	8	8	4	20
	Recuento esperado	9.1	7.9	3	20
	% dentro de ¿Tipo de empresa donde labora?	40.00%	40.00%	20.00%	100.00%
	% dentro de ¿Nivel de experiencia en el manejo de BIM?	17.40%	20.00%	26.70%	19.80%
	% del total	7.90%	7.90%	4.00%	19.80%
Independiente	Recuento	9	0	0	9
	Recuento esperado	4.1	3.6	1.3	9
	% dentro de ¿Tipo de empresa donde labora?	100.00%	0.00%	0.00%	100.00%
	% dentro de ¿Nivel de experiencia en el manejo de BIM?	19.60%	0.00%	0.00%	8.90%
	% del total	8.90%	0.00%	0.00%	8.90%
Total	Recuento	46	40	15	101
	Recuento esperado	46	40	15	101
	% dentro de ¿Tipo de empresa donde labora?	45.50%	39.60%	14.90%	100.00%
	% dentro de ¿Nivel de experiencia en el manejo de BIM?	100.00%	100.00%	100.00%	100.00%
	% del total	45.50%	39.60%	14.90%	100.00%

Pruebas de chi-cuadrado

	Valor	df	Significación asintótica (bilateral)
Chi-cuadrado de Pearson	18.012[a]	6	0.006
Razón de verosimilitud	20.429	6	0.002
Asociación lineal por lineal	1.517	1	0.218
N de casos válidos	101		

a. 7 casillas (58.3%) han esperado un recuento menor que 5. El recuento mínimo esperado es 1.34.



Quantitative Variable Analysis

Three indicators were analyzed: average project delay time, average additional cost from delay, weekly average hours dedicated to BIM coordination. All showed non-normal distribution (positive skewness and high kurtosis according to Kolmogorov-Smirnov and Shapiro-Wilk, $p<0.001$). Most projects show low values, with outliers raising the mean in each variable. Hypothesis tests and associations among quantitative variables were performed. Average delay time was compared with a hypothetical value of 5 days using Wilcoxon (due to non-normality), resulting in a significantly lower value ($p<0.05$). No significant correlation was found between coordination hours and delays ($r=0.016$, $p=0.872$). Comparisons between experience groups showed significant differences in median delay times by ANOVA or non-parametric tests.

Table 4 Normality tests

Pruebas de normalidad						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Estadístico	gl	Sig.	Estadístico	gl	Sig.
Tiempo promedio de retraso por proyecto (en días).	0.26	100.00	-	0.67	100.00	-
Costo promedio adicional generado por retraso (en dólares).	0.34	100.00	-	0.44	100.00	-
Horas promedio semanales dedicadas a coordinación BIM.	0.24	100.00	-	0.70	100.00	-
a. Corrección de significación de Lilliefors						

Tabla 5 Test for a sample

Estadísticas para una muestra				
	N	Media	Desv. Desviación	Desv. Error promedio
¿Frecuencia de retrasos en la entrega de modelos BIM?	101	1.8713	0.80825	0.08042

Prueba para una muestra						
	Valor de prueba = 5					
	t	gl	Sig. (bilateral)	Diferencia de medias	95% de intervalo de confianza de la diferencia	
					Inferior	Superior
¿Frecuencia de retrasos en la entrega de modelos BIM?	-38.903	100	0	-3.12871	-3.2883	-2.9692

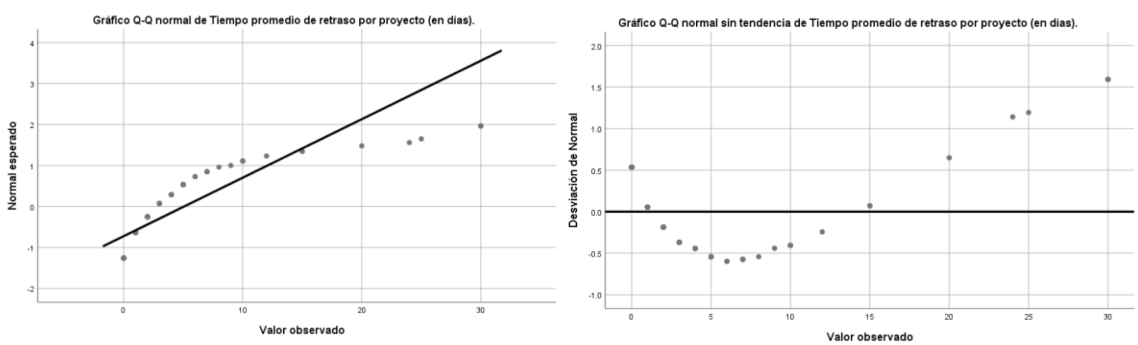


Figura 1 Stem and leaf chart for lag time

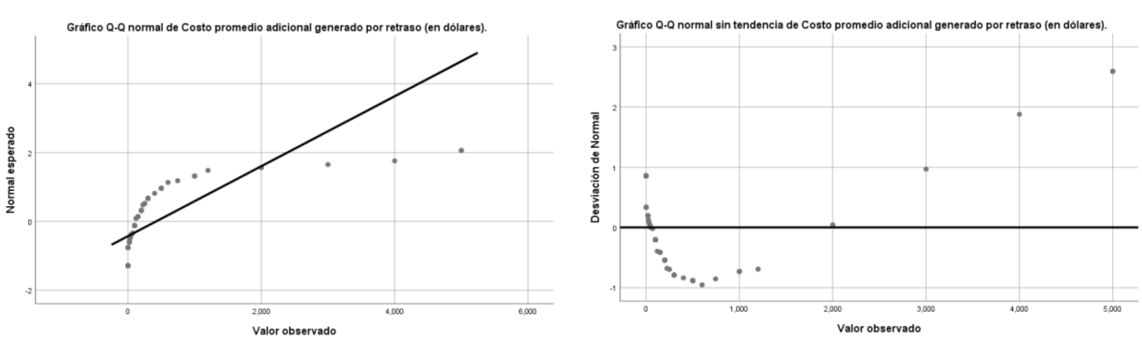


Figura 2 Stem and leaf chart for additional cost

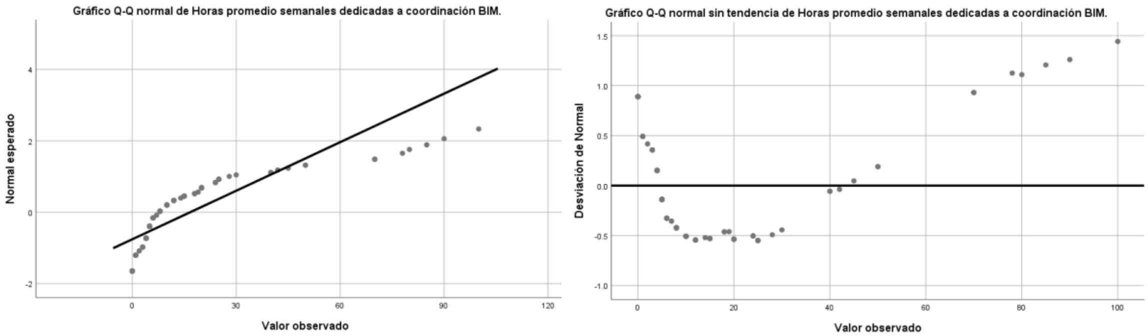


Figura 3 Stem and leaf chart for weekly coordination hours

Most of the projects show low values, with the presence of outliers that raise the mean in each variable.

Hypothesis testing and associations between quantitative variables

The average delay time was contrasted with a hypothetical value of 5 days using the Wilcoxon test (due to non-normality), resulting significantly lower ($p<0.05$).

Table 6 One-sample Kolmogorov-Smirnov test

Prueba de Kolmogorov-Smirnov para una muestra		
		¿Frecuencia de retrasos en la entrega de modelos BIM?
N		101.00
Parámetros normales[a,b]	Media	1.87
	Desv. Desviación	0.81
Máximas diferencias extremas	Absoluto	0.23
	Positivo	0.23
	Negativo	-0.20
Estadístico de prueba		0.23
Sig. asintótica(bilateral)		.000[c]
a. La distribución de prueba es normal.		
b. Se calcula a partir de datos.		
c. Corrección de significación de Lilliefors.		

No significant correlation was detected between coordination hours and delays ($r=0.016$, $p=0.872$).

Table 7 Correlation between variables

Correlaciones			
		Tiempo promedio de retraso por proyecto (en días).	Horas promedio semanales dedicadas a coordinación BIM.
Tiempo promedio de retraso por proyecto (en días).	Correlación de Pearson	1	0.016
	Sig. (bilateral)		0.872
	N	101	100
Horas promedio semanales dedicadas a coordinación BIM.	Correlación de Pearson	0.016	1
	Sig. (bilateral)	0.872	
	N	100	100

Comparisons between groups and paired samples

When comparing groups according to level of experience (low, medium, high), significant differences were detected in the median delays by ANOVA or nonparametric tests.

Tabla 8 Wilcoxon for paired samples

Prueba de muestras emparejadas									
		Diferencias emparejadas					t	gl	Sig. (bilateral)
		Media	Desv. Desviación	Desv. Error promedio	95% de intervalo de confianza de				
					Inferior	Superior			
r 1	¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja? - ¿Nivel de experiencia en el manejo de BIM?	-0.11881	1.15141	0.11457	-0.34611	0.10849	-1.037	100	0.302

Rangos				
		N	Rango promedio	Suma de rangos
¿Nivel de satisfacción con los actuales procesos de gestión BIM? - ¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja?	Rangos negativos	6[a]	16.83	101
	Rangos positivos	79[b]	44.99	3554
	Empates	16[c]		
	Total	101		

a. ¿Nivel de satisfacción con los actuales procesos de gestión BIM? < ¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja?

b. ¿Nivel de satisfacción con los actuales procesos de gestión BIM? > ¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja?

c. ¿Nivel de satisfacción con los actuales procesos de gestión BIM? = ¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja?

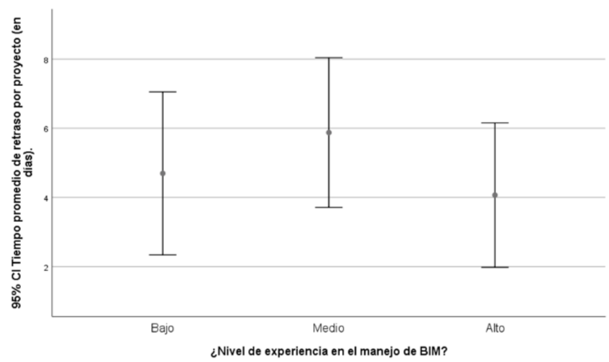
Estadísticos de prueba[a]	
	¿Nivel de satisfacción con los actuales procesos de gestión BIM? - ¿Dentro del campo de acción (Diseño y construcción), en qué área trabaja?
Z	-7.648[b]
Sig. asintótica(bilateral)	0

a. Prueba de rangos con signo de Wilcoxon

b. Se basa en rangos negativos.

Tabla 9 ANOVA by level of experience

ANOVA					
Tiempo promedio de retraso por proyecto (en días).					
	Suma de cuadrados	gl	Media cuadrática	F	Sig.
Entre grupos	47.467	2	23.734	0.483	0.618
Dentro de grupos	4817.047	98	49.154		
Total	4864.515	100			



Discussion

This study highlights the complexity of factors influencing the management and outcomes of projects developed with BIM methodology in the Latin American context. Among the associations between qualitative variables, it is noteworthy that only the relationship between company type and experience level was statistically significant (χ^2=18.012, df=6, p=0.006), with a medium association magnitude. This result corroborates the fundamental role of organizational structure and professional background in the digital maturity of teams, aligning with findings reported in international research (Succar et al., 2022). Independent firms concentrate on the lowest levels of BIM experience, while consultancies and clients exhibit greater diversity and experience, suggesting the need for specialized training strategies to foster competency development among less experienced actors.

In contrast, other organizational variables such as work area (design, execution, supervision) and BIM software used showed no significant association with the frequency of delays or professional satisfaction. The widespread use of Revit (80.2%) could limit the detection of possible differences between tools, a phenomenon already noted in the literature when a single technology dominates sector samples (Eastman et al., 2018; Chong et al., 2017). Thus, project success seems to depend less on specific software and more on comprehensive management practices and the human component (Gu & London, 2010; Martínez-Rojas et al., 2016).

Analysis of the quantitative variables revealed highly skewed distributions and pronounced kurtosis, evidenced by the existence of a small group of projects with delays, cost overruns, or excessive coordination hours that skew the mean. This dispersion supports the use of nonparametric methods and focuses attention on the importance of identifying and managing outlier cases to optimize resources and results (Barbosa et al., 2017). Additionally, no significant correlations were detected between coordination hours and delays, suggesting that the extent of coordination alone does not guarantee better results, reinforcing the idea that efficiency depends on process quality and team experience.

When analyzing group comparisons, it was found that participants with less experience reported greater delays, making it essential to design targeted training and mentorship programs for this segment, in line with previous studies' recommendations to strengthen digital maturity and reduce result variability (Martínez-Rojas et al., 2016; Succar et al., 2022). One of the main limitations of the study is the small sample size in certain categories (particularly for software other than Revit) and the presence of cells with low counts in contingency tables, which may affect the validity of some tests and require regrouping categories in future analyses. Likewise, it would be valuable to complement these findings with qualitative techniques and longitudinal studies to analyze the impact of proposed interventions. The results reinforce the need to develop focused training strategies and improvement interventions in BIM project management, ensuring that experience and organizational learning drive efficiency, beyond the functional area or chosen technological tool. These findings are consistent with international literature and offer relevant input for guiding decision-making and sector development policies.

CONCLUSIONS

Comprehensive analysis of organizational and quantitative variables in BIM projects shows that the only statistically significant association between qualitative variables corresponds to the intersection of company type and experience level ($\chi^2=18.012$, df=6, p=0.006), a finding consistent with Succar et al. (2022) regarding the role of organizational structure in BIM team digital maturity. Independent firms concentrate the lowest experience levels, while consultancies and clients present greater plurality; this pattern suggests targeting training and mentorship strategies toward the sector's less experienced actors.

Conversely, no significant association was found between functional areas (design, execution, supervision) or main BIM software and the frequency of delays or professional satisfaction—results aligned with literature highlighting the multifactorial nature and predominant influence of human and management factors over technological tools in project efficiency (Eastman et al., 2018; Gu & London, 2010). The widespread use of Revit observed limits the potential for software comparison, reinforcing the need to expand samples and categories for future research.

The quantitative variables analyzed showed non-normal distributions, with positive skewness and high kurtosis, revealing outlier cases that concentrate the main delays, cost overruns, or coordination hours. This behavior validates the prioritization of nonparametric methods and draws attention to the importance of identifying and managing outlier projects to optimize overall outcomes (Barbosa et al., 2017). Moreover, it was found that higher experience levels were associated with shorter delay times, reinforcing the relevance of training, in line with findings by Martínez-Rojas et al. (2016).

Key recommendations include regrouping underrepresented categories and prioritizing sample expansion, as well as deepening the analysis of organizational and personal context variables. It would also be pertinent to complement future work with qualitative techniques and longitudinal studies to assess the real effect of strategic interventions and their sustainability over time.

These results support the strategic relevance of training and experience in improving key indicators of BIM project management and provide robust empirical evidence to support practices and policies that drive efficient digital transformation in the construction sector (Chong et al., 2017; Succar et al., 2022).]

REFERENCES

Barbosa, F., Woetzel, J., Mischke, J., Ribeirinho, M. J., Sridhar, M., Parsons, M., ... & Brown, S. (2017). Reinventing construction: A route to higher productivity. McKinsey Global Institute.

Chong, W. K., Lopez, R., Wang, J., Wang, X., & Zhao, M. (2017). Comparative analysis on the adoption and use of BIM in South Korea, Hong Kong and the USA. Construction Innovation, 17(4), 602-618. https://doi.org/10.1108/CI-05-2016-0026

Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2018). BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers (3rd ed.). John Wiley & Sons.

Gu, N., & London, K. (2010). Understanding and facilitating BIM adoption in the AEC industry. Automation in Construction, 19(8), 988-999.

Martínez-Rojas, M., Marín, N., & Vila, M. A. (2016). The Role of Information Technologies to Address Data Handling in Construction Project Management. Journal of Computing in Civil Engineering, 30(4), 04015064. https://doi.org/10.1061/(ASCE)CP.1943-5487.0000521

Succar, B., Kassem, M., Dawood, N., & Forgues, D. (2022). BIM Maturity and Digital Transformation in Construction: An International Review. Automation in Construction, 137, 104224. https://doi.org/10.1016/j.autcon.2022.104224.