



Impact of Modern Construction Technologies (MCT) on Project Delivery Success: A Statistical Evaluation



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Abstract

This study investigates how the application of Modern Construction Technologies influences project delivery performance in terms of schedule, cost, and quality outcomes. The study analyzed the impact of the MCT Adoption Index (MCTAI) on project performance using multiple regression and moderation analyses based on a survey of 500 respondents. The results indicated that there is a clear and consistent pattern that the higher the level of MCT adoption, the better the schedule adherence, the better the cost performance, and the better the quality outcomes. The organizational context also had a positive influence on the projects' performance, but it did not significantly change the strength of the relationship between MCT adoption and delivery outcomes. These results implied that the benefits of modern technologies are mostly direct and independent of contextual variations, underpinning their crucial role in enhancing coordination, reducing inefficiencies, and strengthening delivery reliability. The study also adds to the literature by providing solid statistical evidence based on a composite measure of technology adoption that overcomes the common limitation of binary indicators often used in previous research. The construction firms, therefore, are called upon to invest in building digital capability and integrating technological systems into their managerial structures. Given the cross-sectional design of the study, causal inference is limited; however, it lays a strong foundation for further longitudinal studies probing how digital transformation keeps shaping project delivery performance.

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1 Introduction

Modern construction technologies (MCT) encompass digital and industrialized methods such as building information modelling (BIM) and digital twins; 3D scanning, drones and robotics for site capture and automation; AI/ML-enabled planning, risk and cost control; common data environments (CDEs) and open data schemas; plus offsite, modular and 3D-printed construction (Sepasgozar et al., 2023). These tools emerged in response to construction's persistent delivery issues, schedule slippage, cost overruns, and uneven quality despite decades of procedural reforms (Yashchenko et al., 2024). A credible motivation for a statistical study is the sector's well-documented pattern of forecast error in major projects. The widely cited Flyvbjerg database, now covering over 16,000 projects across 25 types, has shown systematic cost and demand forecasting errors, underlining the scale of the delivery challenge that MCTs aim to address (Välilä, 2024).

Evidence about how much MCTs improve project delivery is fragmented and often method-specific (e.g., BIM alone, drones alone) or based on small case samples without adequate controls for project size, complexity, delivery model, market conditions, or team capability (Mehdipoor, 2024). In practice, many firms pilot tools but fail to embed standards and workflows across the full lifecycle, so benefits remain patchy (Afzaal, 2023). Recent global survey data indicate diffusion has plateaued, with only about 12% of respondents reporting using digital tools on all their projects (across six core functions), with most adoption concentrated on "some" or "most" projects rather than "all." This persistence of partial adoption complicates causal claims and highlights the need for controlled, statistical evaluation of MCT adoption intensity versus outcomes (Royal Institution of Chartered Surveyors, 2024).

The statistical estimate of the correlation between MCT implementation and the success of the implementation would be robust and assist the owners and contractors in focusing on investments that can significantly affect the schedule, cost, and quality. The findings can be incorporated at the industry and policy levels to support BIM execution planning, procurement criteria (e.g., capability/maturity scoring), data standards, and development of the workforce. The possible advantage here is also non-trivial: modular/offsite methods have been proven to be 20-50 percent faster to deliver (and potentially even to save a significant fraction of the cost under the right circumstances), a pointer that technology-process integration can effectively reduce timelines substantially, with appropriate scaling. RAD Urban gives a good example of a modular supplier, which aims at making a saving of approximately 30 per cent in high-rise buildings and 20 to 25 per cent in mid-rise projects. The corporation will outsource all on-site labor (between 85-90 per cent) to the factory, where it is estimated that labor is double as efficient as construction on-site and where hourly salaries will provide a considerable source of cost reduction (Bertram et al., 2019). Automation is envisaged as the next step and is expected to deliver an exponential increase in productivity. The ambition is to progress from roughly twice the productivity of traditional construction methods towards a future tenfold advantage (Bertram et al., 2019). Additional costs also arise from the need to duplicate certain elements so that modules can be transported safely. All properties must be structurally sound in situ, and units produced through off-site methods must also remain structurally sound when they are lifted, transported, and assembled. Key structural elements such as beams, columns, and, in some cases, walls and floors, therefore, need to be repeated within three-dimensional modules for transportation, which can materially increase costs depending on the material choice and the level of design optimization (Bertram et al., 2019). Several countervailing savings can reduce the overall cost by approximately 20 per cent. Direct procurement by the factory can remove intermediaries. Centralized purchasing also provides greater control over the timing and consolidation of deliveries, which can lower logistics costs. Economies of scale accrue when a factory procures for all units passing through its production line rather than for individual projects. Quantifying whether such gains generalize across projects and technologies and under what conditions would close an important evidence gap (Esfahbodi et al., 2016).

Modern construction technologies include BIM, digital twins, reality capture, automation, AI, CDEs, and modular manufacture (Hu et al., 2022; Forbes & Ahmed, 2010; Nouh et al., 2024). Acceleration includes generative artificial intelligence in modelling workflows and ethics for data governance (Derrick, 2025). Mechanisms reduce uncertainty, compress interfaces, and create visibility that improves outcomes (Mahamadu et al., 2019). Technology can add coordination burdens and logistics challenges when complements are weak (Goh & Loosemore, 2017). The review adopts a theoretical lens and a conceptual model with controls (Mansour et al., 2022). Evidence on schedule, cost, and quality reveals a gap requiring robust statistical evaluation (Albert et al., 2024; Ahmed & El-Sayegh, 2020). The review emphasizes interactions between technology, logistics, governance, and human capability to realize performance (Kujanpää, 2024).

The literature identifies the benefits of technology-enabled time control by focusing on multidisciplinary design and construction teams that must manage interfaces and constraints across trades, suppliers, and design disciplines in dynamic environments that are sensitive to late information and coordination failures (Forbes & Ahmed, 2010). Generative design approaches can reduce front-end iteration by exploring algorithmic alternatives that satisfy spatial and regulatory constraints, which shortens the time to freeze design and reduces later changes that often disrupt critical paths in delivery programs (Yan et al., 2025). Integration of artificial intelligence, Automation, and robotics helps to accelerate routine tasks, which reduces times and lowers the chance of rework triggered by inconsistent documentation (Derrick, 2025; Kujanpää, 2024; Akinradewo et al., 2021). Delivery system choice interacts with performance because incentives and information rights differ across contractual forms, which can either enable or inhibit the sharing of models, schedules, and constraints that are needed to manage interfaces and compress variance against the baseline (Nouh et al., 2024; Albert et al., 2024; Moradi & Kähkönen, 2022). Empirical work on building information modelling capability finds associations with time performance when maturity reaches thresholds that support effective coordination, which supports the focus on composite capability indices rather than binary adoption indicators in statistical models (Waqar et al., 2025; Mahamadu et al., 2019).

Referring to the cost mechanisms, cost reduction includes the prevention of clashes through coordinated models, the reduction of rework through digital quality assurance, procurement efficiencies from centralized purchasing in factories, learning curves in modular production, and lower waste rates in factory settings compared with traditional sites (Albert et al., 2024). Automation and robotics create cost efficiencies by shortening cycle times and improving repeatability, provided that tasks are sufficiently consistent and that the capital cost of machines is amortized over adequate volumes of work with stable demand from project pipelines (Akinradewo et al., 2021; Ahmed & El-Sayegh, 2020; Goh & Loosemore, 2017). Integrated practices aim to counter these pressures by promoting standard products, stable interfaces, and platform thinking that reduces variety and enables bulk purchasing, which then translates into lower unit costs and more predictable commercial outcomes on repetitive elements of a programme (Kujanpää, 2024). Empirical work on capability maturity shows associations with improved cost performance when organizations invest in the routines and data governance that support dependable coordination, which again supports the use of composite indices for technology intensity in quantitative models of performance (Waqar et al., 2025). Strategic studies in the post-pandemic era emphasize adaptability and resilience as ingredients of success, which suggests that dynamic capabilities that reconfigure processes and supply relationships will moderate the effect of technology on cost outcomes under conditions of volatility and disruption (Ghanbaripour et al., 2025).

The quality outcome identifies who is accountable for outcomes by emphasizing site managers, quality engineers, design coordinators, and commissioning teams who implement digital checklists, traceable inspection records, and standardized work that together support first-time pass at handover and stable performance in early operation (Moradi & Kähkönen, 2022). The required development is the Sensing and diagnostics technologies that help in detecting defects and thermal bridges, as well as non-destructive validation of building services performance, which helps to correct the problem in time and minimize the chances of the expensive rework following the installation of finishes (Kim et al., 2023). Digital documentation methods enhance the recording and maintenance of a project life cycle in the way information about assets is stored and improve continuity and traceability, which are beneficial in the handover and further interventions of the built environment (Bentkowska Kafel & MacDonald, 2018). Digital twins offer where and when for continuous monitoring and predictive analytics by linking models with real-world data in near real time, which can identify deviations from expected performance and support early corrective action before defects propagate through dependent tasks (Hu et al., 2022). Automation reduces human error in repetitive and precision-dependent tasks and can maintain consistent quality within tolerance limits that are difficult to achieve on congested sites, which is why factory environments often show stronger quality improvements than highly bespoke on-site activities (Akinradewo et al., 2021). It is also said that generative artificial intelligence introduced into modelling ecosystems introduces both ethical and governance issues around bias, description, and provenance of design suggestions, which should be managed by policy and oversight to make sure quality is improved and not undermined by algorithmic tools (Derrick, 2025; Yan et al., 2025).

Theoretically, the Resource-Based theory explains who can gain a performance advantage from technology, what kinds of resources and capabilities underpin that advantage, where such capabilities are embedded and combined, when advantage will persist, why rivals cannot easily imitate capability bundles, and how managers orchestrate complementary assets to extract value from technological change (Mansour et al., 2022). Within this framework, modern construction technologies are not isolated tools but are part of capability systems that combine digital artefacts, codified processes, and human expertise into routinised ways of working that can become valuable, rare, difficult to imitate, and organized for advantage when appropriately governed and resourced (Wibisono & Supoyo, 2023; Albert

et al., 2024). Evidence from industrialization in construction shows that the redistribution of knowledge and control between main contractors and subcontractors alters who holds critical capabilities, what routines create value, and how coordination is achieved across interfaces, which is consistent with the Resource-Based View emphasis on capability configuration and appropriation of returns (Goh & Loosemore, 2017). Empirical work on building information modelling capability supports the proposition that capability maturity rather than binary adoption is the appropriate construct for explaining delivery outcomes, which aligns with the Resource-Based View notion that performance depends on the depth and orchestration of complementary resources and routines (Mahamadu et al., 2019). Collaborative delivery studies show that process alignment and governance mechanisms interact with capability to shape success, which indicates that advantage is embedded where organizational structures, team behaviors, and technological routines are coherently aligned around delivery objectives and transparent information flows (Moradi & Kähkönen, 2022). Managerial accounts of integrated practices further reinforce the idea that lean design management, reliable promising, and stable work packages act as complements to digital capability, which together enable organizations to convert potential efficiency into realized improvements in schedule, cost, and quality (Forbes & Ahmed, 2010; Nouh et al., 2024; Bayır, 2024; Lifelo et al., 2024).

The aim of the study is to statistically evaluate the impact of modern construction technologies on project delivery success. For this purpose, the study evaluates the operationalized procedures including schedule performance, cost performance, and quality outcomes. Given the research aim, the study exclusively looks into estimating the association between MCT adoption intensity and cost performance, schedule performance, and quality outcomes (Baiden & Price, 2011).

2 Materials and Methods

This research employed a quantitative cross-sectional research design to statistically test the effects of the modern construction technologies (MCT) on the project delivery success (Magano et al., 2024). Following an explanatory research design, the study aims to determine the degree to which adoption of MCT applies in project performance in terms of schedule, cost, and quality outcomes, with the introduction of the moderating effect of organizational context. The analytical design facilitates the causal inferences due to multivariate regression and a moderation model on the basis of empirically measured data on the completed construction projects (Price & Lovell, 2018). The target population for the study was professionals who are actively engaged in the implementation of construction projects, such as architects, contractors, consultants, project managers, and site engineers. The sampling strategy was stratified to guarantee a representative sample of the role and the type of projects. There were 500 valid responses, which displayed various sizes of projects (small, medium, and large), different types of organizations (client, consultancy, contractor, design firm, and others), and different geographic areas. Such heterogeneity makes the results applicable to the construction sector in general (Almusaed et al., 2025). The main data collection tool was a structured questionnaire based on the validated scale of previous research on the adoption of construction technologies and the performance of a project. Each of the constructs was assessed with some items on a five-point Likert scale with the range of 1 (strongly disagree) to 5 (strongly agree). The questionnaire covered MCT Adoption Index (MCTAI), Project Delivery success through constructs of Schedule Performance (SCP), Cost Performance (COP), and Quality Outcome (QUO); and Organizational Context (ORC). Internal consistency was checked by the reliability analysis, and the results showed that all constructs reported Cronbach's alpha greater than 0.89, and this is a strong indication of reliability (Table 3). Analysis of data was done through SPSS to describe the demographics and project characteristics; descriptive statistics were initially calculated. Associations between preliminary relationships between MCT adoption and outcomes of the project were then analyzed using correlation analysis (Jaymin-Sanchaniya et al., 2024). After that, the sets of multiple linear regression analyses were carried out to predict the direct impacts of MCTAI and ORC on the schedule, cost, and quality performance (Tables 5–7). Assumptions of normality, multicollinearity, and homoscedasticity were satisfactorily met in the regression models. In order to investigate conditional effects, a moderation analysis was conducted through ORC, which was added to check the relationship between MCT adoption and each outcome of performance (Tables 8 and 9). This allowed testing the possibility of the strength of MCT to depend on various organizational conditions. The respondents were free to participate, and their confidentiality was ensured. No personal details were obtained. The research meets the ethical standards of research in the area of informed consent, data integrity, and data analysis transparency (Mertens et al., 2017).

3 Results and Discussions

This section provides results and analysis of the quantitative dataset that has been collected from the survey questionnaire. According to Table 1, the sample exhibited an equal representation of the different roles throughout the construction industry with site engineers (21%) and project managers (19) constituting the greatest groups with architects (15%), contractors (14%), clients/owners (13.8%), and consultants (12%) coming in second, third, fourth and fifth respectively. The majority of the participants were very career-experienced, with 27.2% having 11-15 years of experience, 24.2% having 5-10 years of experience, and 18.6% having 16-20 years' experience

3.1 Distribution Analysis

Table 1
Summary of Demographic Indicators

Variable	Category	Frequency	Percent	Valid Percent	Cumulative Percent
Role	Architect	75	15.0	15.0	15.0
	Client/Owner	69	13.8	13.8	28.8
	Consultant	60	12.0	12.0	40.8
	Contractor	70	14.0	14.0	54.8
	Other	26	5.2	5.2	60.0
	Project Manager	95	19.0	19.0	79.0
	Site Engineer	105	21.0	21.0	100.0
Experience	<5	70	14.0	14.0	14.0
	>20	80	16.0	16.0	30.0
	11–15	136	27.2	27.2	57.2
	16–20	93	18.6	18.6	75.8
	5–10	121	24.2	24.2	100.0
Qualification	Bachelor	205	41.0	41.0	41.0
	Diploma	28	5.6	5.6	46.6
	Doctorate	57	11.4	11.4	58.0
	Master	183	36.6	36.6	94.6
	Other	27	5.4	5.4	100.0
Organization Type	Client/Owner	90	18.0	18.0	18.0
	Consultancy	100	20.0	20.0	38.0
	Contractor	97	19.4	19.4	57.4
	Design firm	91	18.2	18.2	75.6
	Other	122	24.4	24.4	100.0

Most of them were very qualified with bachelors (41%), or master degrees (36.6). The sample was selected based on diverse types of organizations, as percent were consultancies, 19.4 percent were contractors, 18.2 percent were design firms, and 18 percent were client/owner organizations.

Table 2
Summary of Project-Based Indicators

Variable	Categories	Frequency	Percent
Project Size	Large (>\$50M)	85	17.0
	Medium (\$5–50M)	237	47.4
	Small (<\$5M)	178	35.6
Project Sector	PPP	59	11.8
	Private	287	57.4
	Public	154	30.8
MCT Utilization	No	69	13.8
	Yes	431	86.2
	Total	500	100.0

Variable	Categories	Frequency	Percent
Project Complexity	High	155	31.0
	Low	170	34.0
	Moderate	175	35.0
Delivery Model	Design–Build (DB)	136	27.2
	Engineering, Procurement, and Construction (EPC)	117	23.4
	Other	104	20.8
	Traditional (Design–Bid–Build)	143	28.6
Region	International / Cross-border project	131	26.2
	Rural	105	21.0
	Semi-urban	117	23.4
	Urban / Metropolitan	147	29.4
	Total	500	100.0
Project Type	Commercial	60	12.0
	Industrial	98	19.6
	Infrastructure	95	19.0
	Institutional	88	17.6
	Mixed-use	82	16.4
	Residential	77	15.4

Table 2 summarizes some of the key project-based indicators, in which the majority of projects were medium in size, 47.4%, and from the private sector, 57.4%, indicating a strong private investment in construction. A high share reported the use of MCTs, 86.2%, thus indicating an extensive adoption of technologies within the industry. As regards the level of complexity, the projects were relatively well balanced, with 35% being moderate, 34% low, and 31% highly complex. Traditional and design–build delivery models represented 28.6% and 27.2%, respectively, while urban and metropolitan projects constituted the largest regional category, with 29.4%. The project types were industrial and infrastructure, together taking a significant share and reflecting the diversity of the sample across functional and operational contexts.

3.2 Reliability Statistics

Table 3
Reliability Statistics

Description	Cronbach's Alpha	N of Items
MCT Adoption Index (MCTAI)	.908	5
Schedule Performance (SCP)	.895	5
Cost Performance (COP)	.922	5
Quality Outcome (QUO)	.916	5
Organizational Context (ORC)	.908	5

The reliability analysis in Table 3 shows the presence of excellent internal consistency in all constructs of measurement. In particular, the MCT Adoption Index (0.908), Cost Performance (0.922), and Quality Outcome (0.916) have an especially high internal coherence, whereas Schedule Performance (0.895) and Organizational Context (= .908) also indicate a high level of reliability. These findings confirm the consistency and reliability of the questions used in the questionnaires to conduct further statistical analyses.

3.3 Correlation Analysis

Table 4
Correlation Matrix

		MCTAI	SCP	COP	QUO	ORC
MCTAI	Pearson Correlation	1	.829**	.835**	.823**	.854**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	500	500	500	500	500
SCP	Pearson Correlation	.829**	1	.821**	.798**	.833**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	500	500	500	500	500
COP	Pearson Correlation	.835**	.821**	1	.826**	.848**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	500	500	500	500	500
QUO	Pearson Correlation	.823**	.798**	.826**	1	.823**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	500	500	500	500	500
ORC	Pearson Correlation	.854**	.833**	.848**	.823**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	500	500	500	500	500

** . Correlation is significant at the 0.01 level (2-tailed).

Table 4 demonstrates strong and statistically significant positive associations among all variables at the 0.01 level. The MCTAI shows high correlations with Schedule Performance ($r = .829$), COP ($r = .835$), and QUO ($r = .823$), indicating that higher adoption of modern technologies is strongly linked with improved project delivery outcomes. Moreover, MCTAI also exhibits a strong relationship with ORC ($r = .854$), suggesting that favourable organizational settings tend to coincide with higher technology adoption. Similarly, the inter-correlations among the three performance indicators (SCP, COP, QUO) range between .798 and .826, reflecting a coherent alignment across different dimensions of project success.

3.4 Analysis of the Relationship between Variables

The overall findings of the three regression models indicate a high and statistically significant effect of the adoption of MCT on the overall project delivery success that is measured using schedule performance, cost performance, and quality outcomes. The high levels of explanatory power in each of the models demonstrate that a combination of the MCT adoption and organizational context has a considerable share of the variance in project delivery indicators.

Table 5
Model Summary for Regression Models

Dependent Variable	R	R Square	Adjusted R Square	Std. Error of the Estimate
Schedule Performance (SP)	0.863	0.744	0.743	0.282
Cost Performance (CP)	0.874	0.764	0.763	0.298
Quality Outcome (QO)	0.855	0.731	0.729	0.315

Table 5 provides the model summary output of the three regression equations that test the effect of the Modern Construction Technologies Adoption Index (MCTAI) and the Organizational Context (ORC) on the project delivery beliefs. The findings indicate that the model fits very well in all three dependent variables. In the case of Schedule Performance (SP), the model accounts for 74.4% of the variation ($R^2 = 0.744$), whereas Cost Performance (CP) and Quality Outcome (QO) note 76.4% and 73.1% explanatory contents, respectively. The R-values are always high ($=0.855-0.874$), which verifies that there are strong linear relationships between predictors and dependent variables.

Table 6
ANOVA Estimates for Regression Models

Dependent Variable	Source	Sum of Squares	df	Mean Square	F	Sig.
SCP	Regression	115.029	2	57.515	723.919	.000
	Residual	39.486	497	0.079		
	Total	154.516	499			
COP	Regression	143.457	2	71.729	805.992	.000
	Residual	44.230	497	0.089		
	Total	187.687	499			
QUO	Regression	133.787	2	66.894	673.654	.000
	Residual	49.352	497	0.099		
	Total	183.140	499			

Table 6 presents the ANOVA estimates that prove the overall significance of regression models. In all three models, F-statistics are very significant at $F(2,497) = 723.919$ ($p < 0.001$) in SCP, $F(2,497) = 805.992$ ($p < 0.001$) in CP, and $F(2,497) = 673.654$ ($p < 0.001$) in QO. These findings statistically confirm that the interactive effects of MCTAI and ORC are significant predictors of differences in project delivery outcomes.

Table 7
Coefficient Estimates for Regression Models

Dependent Variable	Predictor	Unstandardized B	Std. Error	Standardized Beta	t	Sig.
SCP	(Constant)	0.305	0.064	—	4.807	.000
	MCTAI	0.440	0.044	0.436	9.997	.000
	ORC	0.432	0.041	0.460	10.533	.000
COP	(Constant)	0.329	0.067	—	4.900	.000
	MCTAI	0.454	0.047	0.409	9.748	.000
	ORC	0.517	0.043	0.499	11.906	.000
QUO	(Constant)	0.346	0.071	—	4.868	.000
	MCTAI	0.489	0.049	0.446	9.943	.000
	ORC	0.452	0.046	0.442	9.862	.000

Table 7 provides the estimates of the coefficients of each of the regression models, which shows that both MCTAI and ORC have strong positive impacts on all three dimensions of project performance. In the case of SCP, MCTAI ($B = 0.440$, $p < 0.001$) as well as ORC ($B = 0.432$, $p < 0.001$) are good predictors. In like fashion, in the Cost Performance model, MCTAI ($B = 0.454$, $p < 0.001$) and ORC ($B = 0.517$, $p < 0.001$) have considerable influence, and ORC has a standardized influence that is slightly stronger (0.499). In the case of QUO, MCTAI ($B = 0.489$, $p < 0.001$) and ORC ($B = 0.452$, $p < 0.001$) come out as significant predictors.

Table 8
Moderation Analysis Summary

Dependent Variable	R	R ²	F (df = 3,496)	Sig. (p)	ΔR^2	F (Interaction)	p (Interaction)
SCP	0.8634	0.7455	484.29	0.000	0.0010	2.03	0.155
COP	0.8743	0.7644	536.52	0.000	0.0001	0.19	0.663
QUO	0.8547	0.7305	448.26	0.000	0.0000	0.05	0.824

Table 8 shows that although the general models are significant, there are no statistically significant interaction effects between MCTAI and ORC in all three dependent variables. The R² values are high (0.7455 of SP, 0.7644 of CP, and 0.7305 of QO), corresponding to the direct models. Nevertheless, the differences in explained variance between

interaction (0.0000 to 0.0010) are negligible, and the resulting F-values of the interaction terms are insignificant ($p > 0.05$). This is an indication that the organizational context does not mediate the relationship between the adoption of MCT and the outcomes of the project performance.

Table 9
Coefficient Estimates of Moderation Models

Dependent Variable	Predictor	B	SE	t	p	95% CI [LLCI, ULCI]
SCP	Constant	0.597	0.214	2.79	0.006	[0.176, 1.018]
	MCTAI	0.327	0.091	3.62	0.000	[0.150, 0.505]
	ORC	0.324	0.086	3.75	0.000	[0.154, 0.494]
	MCTAI × ORC	0.040	0.028	1.42	0.155	[-0.015, 0.096]
COP	Constant	0.424	0.227	1.87	0.063	[-0.022, 0.870]
	MCTAI	0.418	0.096	4.35	0.000	[0.229, 0.606]
	ORGC	0.482	0.092	5.27	0.000	[0.302, 0.662]
	MCTAI × ORC	0.013	0.030	0.44	0.663	[-0.046, 0.072]
QUO	Constant	0.295	0.240	1.23	0.220	[-0.177, 0.766]
	MCTAI	0.509	0.102	5.02	0.000	[0.310, 0.709]
	ORGC	0.471	0.097	4.87	0.000	[0.281, 0.661]
	MCTAI × ORC	-0.007	0.032	-0.22	0.824	[-0.069, 0.055]

The findings from the regression analysis are supported by additional analysis of the estimates of the coefficients in Table 9. The overall impacts of MCTAI and ORC are positive and significant ($p < 0.001$) in all three models, which confirms their direct impact. Non-significant coefficients are also obtained beginning with the interaction terms (MCTAI × ORC) SCP ($B = 0.040$, $p = 0.155$), COP ($B = 0.013$, $p = 0.663$), and QUO ($B = -0.007$, $p = 0.824$). All these findings imply that MCT adoption, organizational context, and organizational context by themselves increase the project delivery success, but there is no significant difference in the impact of MCTAI across the levels of organizational context.

Discussion

Project delivery success is measured through schedule, cost, and quality performance. The results provide clear statistical evidence that MCT adoption significantly enhances all three performance dimensions. Such findings corroborate a growing consensus in construction management research that technological capability now functions as a critical determinant of delivery performance, rather than a supportive input (Nouh et al., 2024; Mahamadu et al., 2019). These findings indicate that there is a strong positive correlation between schedule performance and MCT adoption, meaning that the time efficiency is better in projects where technologies such as BIM, tools of digital planning, and modular or robotic construction methods are adopted. The results are therefore in line with earlier studies that were conducted by Ahmed & El-Sayegh (2020), who argued that digital coordination and real-time information trigger minimal error in sequencing and rework. Based on this, MCTs improve the possibility of improved visualization, clash detection, and task synchronization, which allows project teams to operate and resolve bottlenecks in the schedule. In essence, MCTs enable the reactive scheduling to be changed in predictive control by providing a secure data flow during the entire lifecycle of the project. The observed high results substantiate the findings of other researchers reported previously, who state that modeling and simulation tools increase temporal performance consistency (Kujanpää, 2024). With that said, project management facilitated by technology must become not a secondary but a primary factor that can guarantee an on-time delivery (Gurgu et al., 2024).

Another cause behind the adoption of MCTs in the study also highlights the positive effect of MCTs on the variance in cost performance. It is also possible to say that such an outcome supports the arguments that have been raised earlier by Goh & Loosemore (2017), stating that digital construction means less cost variation because it improves the accuracy of forecasts, minimizes wastage of construction materials, and diminishes rework. With the aid of real-time analytics, integrated design-build models, and automated production, the process of cost control becomes less prone to major and constant deviations (Mansour et al., 2022). The absence of an organizational context modulating effect would imply that these cost benefits were closer to being a technical than a contextual phenomenon. Stated differently,

when the technologies are integrated, the efficiency benefits transpire via automation, accuracy, and openness regardless of the differences in the culture or structure (Rabihati et al., 2025). It has been observed that the digital platform creates value by completely aggregating standardized data instead of managerial judgments. Concisely, MCT adoption has direct structural savings whose net effect is predictability and control of project costs (Ahmed & El-Sayegh, 2020).

The quality consequences are the third pillar of a successful project delivery and are also closely correlated positively with the use of MCT. This finding confirms the results of Kim et al. (2023) that sensing, diagnostics, and data-driven inspection systems incorporated into the digital construction processes increase workmanship and defect control. Digital twins, automated monitoring tools, etc., allow enhancing precision, providing continuous feedback, and ensuring that specifications in design are followed. It is indicated that MCTs are able to boost the quality of the construction by entrenching quality control in the manufacturing of the construction at the stage during which it was made, instead of using post-construction testing. It supports Hu et al. (2022), who stated that combined sensing and feedback control loops decrease the defect paths and improve the reliability of performance. The aggregate findings validate the idea that MCTs do not merely hasten or save on cost, but improve the technical quality and service quality of final projects. Even though there are positive direct effects of organizational context on project outcomes, the effects of organizational context on project outcomes are not significant in all the models. That is to say that delivery success happens directly as influenced by technological capability on its own (Sepasgozar et al., 2023). With the maturity and standardization of digital technologies, their utility appears not to correlate with particular organizational designs, but rather with the quality of their technical implementation (Park et al., 2024). Although the previous research indicated that leadership support and training enhance the advantages of technology, the findings of this study show that technological performance mechanisms become less and less dependent on the contextual conditions. This does not imply that organizational preparedness is useless, but rather it is compared to the fact that, regardless of capability level with a certain minimum rate, there can be a greater level of consistent benefit with technology systems in a variety of contexts. This pattern can be revisited by the researchers across time to determine whether the patterns of moderation evolve with higher levels of maturity in digital governance (Park et al., 2024).

These results build on previous research in a number of ways. To begin with, using an MCT Adoption Index, the study goes beyond a dichotomous adoption indicator and measures the complexity and sophistication of integrating technology, thereby overcoming the measurement issues identified by Mahamadu et al. (2019). Second, it provides empirical rigor to assertions that were originally premised on case evidence or reason, by statistically validating the effects of MCT on multiple constructs—schedule, cost, and quality of delivery.

The intercorrelations between these delivery constructs also have high levels of correlation, and this supports the notion of integrated performance, where an increase in time efficiency leads to costs and subsequently to quality improvements (Baiden & Price, 2011). All these interconnectivity aspects are united in support of the RBV, which views MCTs as strategic resources and generating inter-operational synergies and sustainable competitive advantages in unison (Mansour et al., 2022). In this respect, technological capability is not a mere production instrument but is instead among the ontological premises of project performance systems. Moreover, this study addresses a broader sample that features a diverse set of project types, thus geographic and sectoral limitations of the past studies. According to Nouh et al. (2024), past research studies have concentrated mostly on early adopters or a particular market, thus restricting the generalization of findings. The current findings, thus, contribute to the existing empirical knowledge on a more representative project level and make a more adequate mark of how the MCT adoption contributes towards delivery success in different contexts.

4 Conclusion

The study concludes that MCTs play a big role and contribute towards the success of project delivery particularly in terms of schedule, cost and project quality. CTM adoption is strongly correlated with these performance measures, which validates the argument that technology adoption makes operations excellent in these projects. Organizational context plays its own independent role in the performance, but its moderating effect is also not determined to be statistically significant, implying that MCTs themselves can impose their immediate and strong effect regardless of the contextual differences. It is preferable that the use of MCT in construction companies should be institutionalized with the help of systematic development of capabilities, investment in digital infrastructure, and training of workers. Mechanism of measuring the maturity of technologies and their performance effects should be promoted to facilitate

standard frameworks of evaluation by policymakers and industry associations so as to achieve uniformity and comparability among projects. Future studies would like to study longitudinal and cross-sectoral effects of dynamic effects over time, and to study other moderators, including leadership, the culture of innovation, and the intensity of collaboration, to further elucidate technology-performance linkages between them.

6. Implications, Study Limitations, Future Research Directions

Given the research domain, the study exhibited significant implications for research and practice. It is empirically proven that MCTs are an important driver of project delivery success and, consequently, the importance of digital transformation as an enabler of improved performance in terms of schedule, cost, and quality. In a practical sense, the findings will assist the project managers and policy makers to put the integration of MCTs in their business operations as a strategic and not discretionary capability by focusing on organizational preparedness and training as a way of attaining long-term integration. Nevertheless, certain restrictions should be mentioned. The cross-sectional information restricts the potential of making causal conclusions over time. In addition, particular groups of projects and regions were surveyed, which might limit the ability to consider universal cases in all industry situations. The paper, as well, concentrated primarily on the organizational context as a modulator, and other potentially strong aspects, such as team collaboration, regulatory environment, or the maturity of the technology, were not studied. Future longitudinal research to be carried needs to examine the effects of MCT on the influence of change according to project stages and time. Possibly, the comparison of studies in other sectors and models of delivery can be more detailed in understanding the variability of the context. There is also an urge among the researchers to utilize a multi-level approach and qualitative methodology to develop a measurement of the behavioral and managerial facets of technology adoption, with the outcomes of sustainability and innovation.

Conflict of interest statement

The author declared that he had no competing interests.

Statement of authorship

The author has a responsibility for the conception and design of the study. The author has approved the final article.

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