

Impact of Advanced Technologies and Innovation on Construction Projects Performance

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Abstract

This study examines impact of advanced technologies on construction projects performance. The study used SEM with SmartPLS and adopts positivist epistemology, conducting a cross-sectional survey of 297 professionals in construction through quantitative data analyses of several factors and explore relationship with project management theories such as Resource-Based View, Socio-Technical Systems and Diffusion of Innovation. The study findings show a significant positive relationship between projects innovation practices and project success, with innovating culture significantly moderating this relationship. This research adds to body of knowledge policy and practical implications for managers and policymakers to harness benefits of innovation through adaptive projects management.

Keywords: Projects Performance, Innovative Culture, Projects Interdependencies, Projects Management Practices.

1. Introduction

Today's dynamic global environment of fast-changing technological advancement and economic transition has made effective project innovation a critical success determinant across sectors. The domain of modern project management has expanded far beyond scheduling and budgeting and includes strategic planning, optimal utilization of resources, continuous monitoring, and adaptive solving of problems to be more effective. [8] illustrate that how well one can conceive a project and align it with strategic goals from the very beginning is not just an execution success factor. Despite the improvements in project innovation methodologies, many projects fail because of insufficient strategic planning, inappropriate policies, or inadequate adaptive competencies [5].

The project innovation process is further complicated by the global nature of contemporary projects. [10] noted that most international and cross-organizational

projects amalgamate teams from dissimilar cultural, organizational, and geographical environments. This complexity elevates the need for experienced project managers capable of ideation, risk identification, and informed decision-making. The ability of innovation, brainstorming, and agile practices to alleviate the risks and make projects successful is stressed by [29]. However, a lot of progress has been achieved in project management theories and tools on the global level, but flexibility and the ability to innovate and learn rest outside the majority of organizations' processes.

[16] point out that this absence of formal learning frameworks results in ad-hoc, informal responses to the challenges that work against long-term performance improvement and innovation. In large, capital-intensive projects, delays, cost overruns, and resource inefficiencies can erode objectives to a great degree [22]. This global pattern reflects the situation in Oman. The nation has accomplished several successful

construction projects, but it has also faced serious failures in reaching its medium and long-term development goals. For instance, one of the most well-known cases is regarding the partial underachievement of the “Oman Vision 2020” to diversify the economy and reduce crude oil dependence [1]. Although efforts are made to grow non-oil sectors, the economy continues to depend heavily on oil, leaving it exposed to global oil prices and oil depletion reserves. This failure to fully benefit from other growth potential sectors indicates a weak project performance and the absence of innovation [20].

Oman’s ambition notwithstanding, progress is patchy, with resistance to innovation, poor project performance, and lack of integration of high tech amongst stakeholders (clients, consultants, contractors, vendors) being an ongoing issue. These challenges undermine the ability of the country to achieve the Vision 2040 targets, especially in economic diversification and sustainable development [28]. Time, cost, quality, and stakeholder satisfaction are all affected by poor adoption of innovative strategies, tools, systems and methodologies.

Based on the above consideration, this study examines the impact of project innovation, represented by innovative design solution (IDS), advanced technology utilization (ATU) and innovative project management practices (IPMP), on enhancing project performance (PP) in Oman’s construction industry. The project interdependencies (PI), mediating and moderating roles, and their relationship with an innovative culture (IC) are also assessed. The topic is timely and of importance. It seeks to empirically demonstrate the vital role of innovation in improving project performance in the Omani construction sector. The research helps to advance academic literature as well as industrial practice by providing new enlightenment about the respective impacts of key innovation dimensions and mediating and moderating variables [9]. The findings help stakeholders, policymakers, contractors, and project managers better understand how to harness innovation to enhance efficiency, minimize risk, and achieve national development goals. Furthermore, this study further backs Oman’s strategic change to the knowledge economy, which aligns with the planks of Vision 2040.

2. Literature Review

Strategic Innovation in Project Management

With the current technological advancements and globalization, it is crucial to develop effective approaches to project innovation that will enable the achievement of project objectives with minimal costs. According to [26], the project managers are now paying more attention to developing plans to achieve the project objectives with the least costs. This shift has changed the definition of Project Management (PM) to encompass a strategic activity where portfolios of projects are in sync with the organization's goals to sustain competitive advantage in fierce environments. According to [18], competitive advantage is achieved by understanding the environment, deciding on an organisation’s place, and integrating innovation. Project managers who adopt such a strategic innovation can manage the project more effectively and use new tools and methods to prevent risks and solve problems. However, this must be done with careful strategic planning: [15] state that innovation is costly, and therefore, the environment for innovation needs to be thoroughly searched to discover the areas that bring real value rather than simply implementing new ideas just because they are innovative.

Innovation’s Impact on Project Performance

The literature presents innovation as positively related to project performance in various aspects. According to [6], the integration of modern technologies in portfolio management helps project managers to overcome operational challenges and improve their productivity and costs. [35] also add that strategic innovation enhances resource management since project managers adjust existing products and processes to new conditions to get the best return on investment. However, the relationship between innovation and performance is not one-way. [24] argue that in a low technological maturity environment, for instance, Oman, the lack of innovation hinders resource utilization and calls for innovation strategies within the country’s capacity. [30] state that globalization and emergent technologies present new threats that can reduce project profitability if not managed. Therefore, it is imperative that innovation is accompanied by effective risk management mechanisms in order to reduce the amount of risk involved. In addition, the use of innovation in problem solving by project managers is effective in managing project environments that are full

of uncertainties. As a result of this, it is possible for managers to provide workarounds to emergent situations, whether it is supplying chain issues or misaligned stakeholders [24]. However, this has shifted from the conventional projects management models, where the emphasis was on service provision rather than outcome achievement; the modern approaches call for efficiency and strategic outcomes.

Innovation and Economic Growth in Oman

Oman's economy has been largely dependent on hydrocarbons, but there is pressure to diversify and advance the process of digitization. Understanding this, the Omani government has set aggressive digitization strategies—over 59 government sectors digitization by 2021—to insulate the economy from oil market shocks [2]. Although these steps demonstrate political will in the process of innovation, the lack of advancement in technology beyond the petrochemical industry prevents broader economic change. According to [21], the development of national infrastructure, high technology industries, and the efficiency of the public sector are the key to the formation of a knowledge-oriented society [23] also note four drivers of structural technological development: customer engagement, digitization of products and business frameworks, decision-making processes, and operational competencies. Oman's Digital Transformation Program is under the Ministry of Transport, Communications, and Information Technology (MTCIT) that automates the public services, fast-tracks project delivery, and facilitates resource-sharing across institutions [36]. These initiatives have the potential to enhance the construction projects performance and generate new sources of non-oil revenues. However, further research is needed to understand the impact of innovation on sustainable construction competitive advantage.

The Transformation of Project Innovation for Construction Performance

The construction industry is the leading indicator of Oman's broader economic development objectives. With a global worth of USD 11.7 trillion in the year 2020, and estimated to rise to USD 14.4 trillion by 2026, the industry is fuelled mainly by government infrastructural spending and technological innovations that include BIM and 3D printing [11]. Construction contributes approximately 9% to the country's GDP and is still the leading sector in terms of employment, with 2,410 ongoing projects worth USD 190 billion in 2020

[1]. This declined by 10.3 % due to low oil prices and the pandemic, but it is expected to bounce back as there is increased investment in infrastructure. Thus, innovation in construction PM is an important factor to consider to sustain the growth.

Further, the use of advanced technologies lead to real-time tracking of the project, identification of the risks that are likely to occur, and management of the stakeholders involved, which helps avoid delays and control costs. However, Omani innovation has only focused on the petroleum sector, while construction procedures have remained conventional. For the construction sector to reach its optimum capacity, the project managers must incorporate cross-industry knowledge and insight, involving the use of virtual reality, IoT sensors, and predictive analysis to make construction sites competent and responsive. Also, construction PM maturity is positively related to the economic diversification measures. According to [11], Oman's long-term development depends on the ability to develop human capital to create value-added products outside oil and gas. Through the incorporation of innovation drivers into construction PM, it is possible for stakeholders to put in place systems and strategies that will encourage innovation, support experimentation, and foster continuous development [3].

Innovation Drivers and Methodologies

Innovation management in projects management (PM) goes beyond brainstorming; it has to be systematic and methodical. According to the Oslo Manual by [30], innovation can be classified into product, process, marketing, and organizational types, which can be used to analyse and redesign projects management processes. [13] and [7] build upon this model by incorporating social innovation with public policy contexts, which emphasizes the necessity of projects management frameworks to tackle societal issues and sustainable development goals. Projects Management Institute (PMI)'s five Process Groups, namely: Initiating, Planning, Executing, Monitoring & Controlling, and Closing, offer a framework of how innovation steps can be implemented from concept development to implementation [34]. However, these processes fail to thrive without the right experimentation and organisational learning climate. According to [4], strategic governance policies and stakeholders' management are the essential foundational elements

that can help to address complexity and create a culture of innovation and discipline.

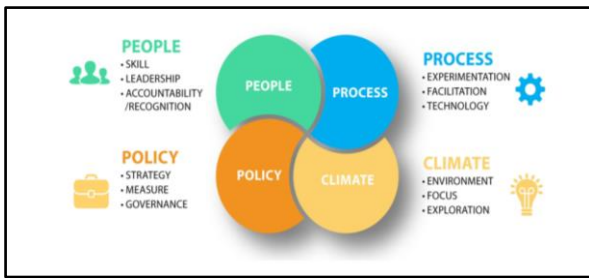


Figure 1. Innovation ecosystem (Source: Alawamleh et al. 2020)

At the methodological level, there are different approaches to combine innovation with PM rigidity, such as using Scrum and Kanban, Lean, Waterfall, and both hybrid approaches [36]. The agile method is best applied when there is a frequent need to go through the development cycle several times and where feedback from the stakeholders is critical, while the lean method is preferred in processes with much waste and less value added. While it is easy to understand the process in well-defined projects due to the waterfall model's linear process, it has no flexibility. Managers have to make sure that the choice of methodology depends on both the complexity and risk of the project and the level of innovation required [37].

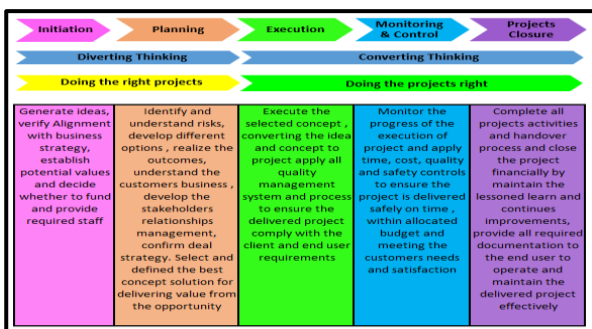


Figure 2. Project Process Group and innovation steps from Diverting to Converting thinking developed by the Author.

Hypotheses and Conceptual Framework

The study focuses on the impact of projects innovation on projects performance as the critical area. The report covers various aspects of corporate management and leadership, particularly the extent to which strategy has contributed to strategic success in the control and effective project management. Data from multiple sources is utilized to facilitate the empirical analysis of the usefulness of integrating innovative strategies into the models of projects innovation to improve the

capacity of project management professionals and practitioners in dealing with the emerging issues and future challenges facing the successful implementation of project management strategies and innovations. The research addresses issues such as: The role of project interdependencies practices and innovative culture in Oman's construction industry projects' performance. The research model is constructed on the following objectives:

1. Identify the impact of projects innovation (innovative design solution (IDS), advanced technology utilization (ATU) and innovative project management practices (IPMP)) on project performance (PP) in construction industry in Oman.
2. To assess the mediating effect of project interdependence (PI) in the relationship between project innovation (innovative design solution, advanced technology utilization and innovative project management practices) and project performance in construction industry in Oman.
3. To observe the moderating effect of innovative culture (IC) on the relationship between project innovation (innovative design solution, advanced technology utilization and innovative project management practices) and project performance in construction industry in Oman.
4. To develop the concept framework reflects the relationships between all research variables.

From the literature reviews, it is clear that projects performance depends on effective alignment, monitoring, and controlling of innovation. Therefore, it is necessary to maximize the project innovation performance to integrate the applications and processes of innovative project management with innovative design solutions, and advanced technology utilization. Based on this and the literature reviews, the main research hypotheses are developed to explore and test the relationships between projects innovation factors and the Omani construction projects performance. The following hypotheses are developed to test and explore the relationships between the constructs:

- H1: Innovative design solution has significant impact on project performance
- H2: Advanced technology utilization has significant impact on project performance

H3: Innovative project management practices have significant impact on project performance

H4: Innovative design solution has significant impact on project interdependence

H5: Advanced technology utilization has significant impact on project interdependence

H6: Innovative project management practices have significant impact on project interdependence

H7: Project interdependence has significant impact on project performance

H8: Project interdependence mediates the relationship between Innovative design solution and project performance

H9: Project interdependence mediates the relationship between advanced technology utilization and project performance

H10: Project interdependence mediates the relationship between Innovative project management practices and project performance

H11: Innovative culture moderates the relationship between Innovative design solution and project performance

H12: Innovative culture moderates the relationship between advanced technology utilization and project performance

H13: Innovative culture moderates the relationship between Innovative project management practices and project performance.

Therefore, the proposed model in Figure 03 suggests that projects depend on the assistance of projects innovation elements to become completely accomplished and result in improved construction performance in Oman.

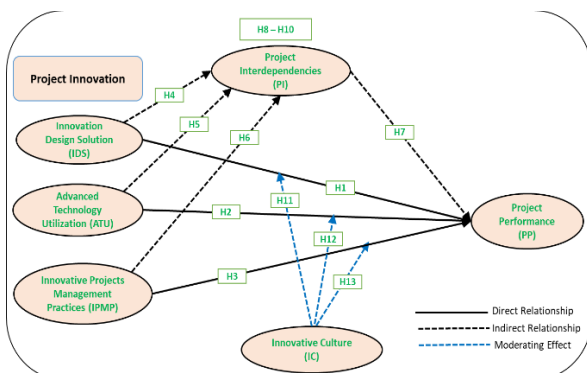


Figure 3. The Conceptual Framework of the Research was developed by the Author.

Theoretical Significance of the Study

The theoretical implications of this study are multifaceted and far-reaching. It advances the Resource-Based View (RBV) theory by highlighting the role of project-level capabilities in mediating resource effectiveness. It contributes to the Socio-Technical Systems (STS) theory by showing the conditional nature of socio-technical alignment and introduces a contingency view of innovative culture's influence. It enriches Diffusion of Innovation (DoI) theory by demonstrating that diffusion is embedded in organizational systems and contingent upon contextual integration. It introduces projects interdependency as a pivotal construct in innovation–performance models, challenges assumptions about innovative culture's universal value, and contextualizes established theories within an emerging market construction industry. Collectively, these contributions significantly advance theoretical understanding in the domains of innovation management, project performance, and construction project execution.

3. Method and Procedures

The current study adopts a positivist paradigm since real-life project situations require multiple approaches, and the truth is revealed through both theory and practice. It employs a deductive approach to examine hypotheses formed in the previous section related to the effects of innovation on project performance in the context of a deductive approach. The study used a combination of cross-sectional, exploratory, and descriptive research: cross-sectional to identify the current practices among Omani project stakeholders; exploratory to identify emergent innovation factors; and descriptive to measure their incidence and correlation.

Further, the study uses a cross-sectional survey design to validate the hypothesis formed from the existing literature, the antecedent factors of innovation in project management. The survey was administered to project management professionals and practitioners in Oman, as well as clients, contractors, consultants, and suppliers. The study employed purposive sampling to ensure the inclusion of only informed respondents; in the second stage, random sampling was employed to arrive at a statistically reasonable sample size and to reduce bias. According to the standard error estimates for multiple regression analysis, it was estimated that at least 278 valid responses would be required to

provide sufficient statistical power (95% confidence level, 5% margin of error).

The survey instrument includes 50 items with 5 Likert scale covering the research constructs of projects innovation, projects interdependencies, innovation culture, and project performance. All items were adopted from existing studies. The survey was distributed to project managers, project engineers, CEOs, contract managers, contractors, consultants, material suppliers, logistics providers, and subcontractors operating within the construction industry in Oman.

4. Data Analysis and Findings

This study presented a thorough analysis of the data using SPSS v26 and Smart-PLS 4.0 to explore the complex relationships among the constructs outlined in the conceptual framework mentioned in Fig.3. The analysis began with preliminary data examination to confirm data quality, including a final valid sample size of 297 responses and a 54% effective response rate. The dataset showed no significant missing values, and Z-score analysis ranging from 1.352 to 2.958, which are within the acceptable threshold ± 3.29 , confirmed the absence of extreme outliers. Although normality tests were carried out and found all item skewness values between (-2.372 and -0.530) remained within the acceptable ± 2 range, but the kurtosis values between (0.504 and 6.427) surpassed 1, revealed moderate non-normality in kurtosis values, the use of PLS-SEM was justified due to its robustness against non-normal distributions and compatibility with complex models. The demographic profile indicated that the respondents were mainly from client organizations (51%) and held positions as engineers and managers with significant professional experience, reinforcing the credibility of the data. Most participants held bachelor's or master's degrees, suggesting a highly educated sample. The measurement model assessment confirmed the reliability and validity of the constructs. As Shown on table 1 and figure 4, all outer loadings in this study range between 0.787 and 0.957, exceeding the minimum threshold 0.7, and Cronbach's alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) values met established benchmarks, affirming internal consistency and convergent validity. Discriminant validity was established using Fornell-Larcker criteria, cross-loadings, and HTMT ratios, confirming that constructs were distinct from one another. The structural model assessment provided

robust evidence supporting the hypothesized relationships. As per table 2, all VIF values (highest at 4.287 and the lowest at 2.864) were below 5.0, ruling out multicollinearity. As per table 3, R^2 values for key endogenous constructs such as Project Performance (PP), Project Interdependencies (PI), and Innovative Project Management Practices (IPMP) were substantial (above 0.75), indicating strong explanatory power. Effect size analysis as per table 4, revealed that Innovative Design Solutions (IDS), Advanced Technologies Utilization (ATU), and Innovative Project Management Practices (IPMP) contributed differently to the outcome variables (PP). For instance, Innovative Project Management Practices (IPMP) showed a medium effect on Project Interdependencies (PI) ($f^2 = 0.238$), while Advanced Technologies Utilization (ATU) had a modest direct impact on Project Performance (PP) ($f^2 = 0.096$). In the direct effect analysis, as per table 5 and figure 5, two of the three hypothesized paths from the independent variables (IV)s to project performance (PP) dependent variable (DV) were supported. H2, Advanced Technologies Utilization (ATU) ($\beta = 0.260$, $p = 0.049$) and H3, Innovative Project Management Practices (IPMP) ($\beta = 0.244$, $p = 0.016$) significantly improved Project Performance (PP), while H1, Innovative Design Solutions (IDS) showed no significant direct effect. All three independent variables, H4, H5 and H6, however, significantly impacted Project Interdependencies (PI), with Innovative Project Management Practices (IPMP) exerting the strongest effect ($\beta = 0.386$, $p = 0.000$). Additionally, Project Interdependencies (PI) had a significant direct influence on Project Performance (PP) ($\beta = 0.390$, $p = 0.006$), supporting its mediating role H7. The mediation analysis confirmed that Project Interdependencies (PI) significantly mediated the effects of Innovative Design Solutions (IDS) H8, Advanced Technologies Utilization (ATU) H9, and Innovative Project Management Practices (IPMP) H10 on project performance (PP), supporting three additional hypotheses. Furthermore, the moderation analysis showed that Innovative Culture (IC) significantly moderated the relationship between Innovative Design Solutions (IDS) and Project Performance (PP) H11, and Innovative Project Management Practices (IPMP) H13 and Project Performance (PP). However, Innovative Culture (IC) does not have any significant influence on the relationship between Advanced Technologies Utilization (ATU) H12 and Project Performance (PP). In

total, 11 out of 13 hypotheses were supported, validating the study’s conceptual model. The findings emphasize that innovative-oriented project interdependencies and favorable advanced technology utilization significantly drive project interdependencies and enhance project performance. Project Interdependencies plays a pivotal mediating role, and

Innovative Culture selectively strengthens key relationships. This study establishes a strong empirical foundation for the theoretical framework, contributing valuable insights for stakeholders aiming to improve project outcomes in the construction industry through strategic innovation management.

Table 1: Internal Consistency and Convergence Validity Results

Constructs	Items	F.L	CA	CR (rho_a)	CR (rho_c)	AVE
CI	CI1	0.846	0.907	0.910	0.935	0.781
	CI2	0.885				
	CI3	0.912				
	CI4	0.893				
CON	CON1	0.903	0.913	0.914	0.945	0.852
	CON2	0.936				
	CON3	0.930				
CP	CP1	0.886	0.885	0.890	0.921	0.745
	CP2	0.873				
	CP3	0.901				
	CP4	0.789				
EFF	EFF1	0.866	0.757	0.765	0.861	0.675
	EFF2	0.848				
	EFF3	0.745				
IC	IC1	0.907	0.960	0.962	0.969	0.863
	IC2	0.956				
	IC3	0.949				
	IC4	0.959				
	IC5	0.870				
PI	PI1	0.833	0.923	0.925	0.942	0.766
	PI2	0.910				
	PI3	0.912				
	PI4	0.898				
	PI5	0.819				
PLAN	PLAN1	0.890	0.905	0.906	0.940	0.840
	PLAN2	0.929				
	PLAN3	0.931				
PP	PP1	0.854	0.931	0.933	0.948	0.784
	PP2	0.918				
	PP3	0.894				
	PP4	0.905				
	PP5	0.854				
SC	SC1	0.860	0.838	0.838	0.903	0.755
	SC2	0.874				

Constructs	Items	F.L	CA	CR (rho_a)	CR (rho_c)	AVE
	SC3	0.873				
SS	SS1	0.874	0.718	0.751	0.846	0.653
	SS2	0.904				
	SS3	0.614				
SUS	SUS1	0.891	0.903	0.903	0.932	0.774
	SUS2	0.869				
	SUS3	0.876				
	SUS4	0.883				
TA	TA1	0.840	0.863	0.868	0.916	0.785
	TA2	0.908				
	TA3	0.908				
IDS	CON	0.883	0.922	0.925	0.935	0.591
	SS	0.953				
	SUS	0.831				
ATU	TA	0.929	0.938	0.940	0.947	0.644
	EFF	0.973				
	CP	0.914				
IPMP	PLAN	0.924	0.923	0.933	0.935	0.593
	SC	0.947				
	CI	0.748				

Notes: CR: Composite Reliability; AVE: Average Variance Extracted; CA: Cronbach's Alpha

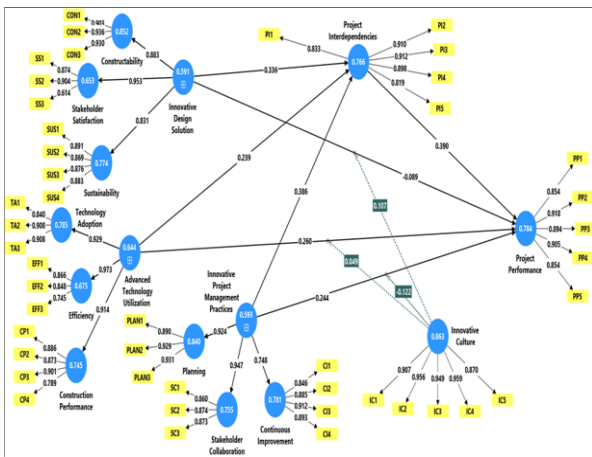


Figure 4. Presented the AVE and factor loadings calculated through PLS-Algorithm

Table 2: Result of multicollinearity – Inner VIF values

Exogenous Variables	PI	PP
ATU	2.884	3.367
IDS	3.206	3.007
IPMP	2.864	4.287
PI		3.015

Table 3: R-square result

Endogenous Variables	R-square	R-square adjusted
CI	0.559	0.558
CON	0.780	0.780
CP	0.835	0.834
EFF	0.947	0.947
PI	0.782	0.779
PLAN	0.855	0.854
PP	0.790	0.784
SC	0.896	0.896
SS	0.908	0.908
SUS	0.691	0.690
TA	0.864	0.863

Substantial > 0.25; Moderate > 0.12, Weak > 0.02 (Cohen, 1989)

Table 4: F-square result

Exogenous Variables	PI	PP
ATU	0.091	0.096
IDS	0.161	0.006
IPMP	0.238	0.066
PI		0.136

Large: f2 effect size > 0.35; Medium: 0.15 < f2 effect size < 0.35; Small: 0.02 < f2 effect size < 0.15;

Table 5: Path coefficient results between Independent, Mediator, Moderator & Dependent Variables

Hypotheses	OS/Beta	SM/B	SD	95% Bias Corrected Confidence Interval		T	P	Decision
				LL	UL			
H1: IDS -> PP	-0.089	-0.083	0.108	-0.296	0.106	0.824	0.410	Not Supported
H2: ATU -> PP	0.260	0.257	0.132	0.008	0.513	1.972	0.049	Supported
H3: IPMP -> PP	0.244	0.255	0.101	0.004	0.424	2.410	0.016	Supported
H4: IDS -> PI	0.336	0.329	0.085	0.195	0.511	3.947	0.000	Supported
H5: ATU -> PI	0.239	0.257	0.103	0.055	0.475	2.317	0.021	Supported
H6: IPMP -> PI	0.386	0.376	0.110	0.174	0.592	3.506	0.000	Supported
H7: PI -> PP	0.390	0.384	0.141	0.139	0.672	2.772	0.006	Supported
H8: IDS->PI-> PP	0.131	0.128	0.062	0.045	0.277	2.113	0.035	Supported
H9: ATU->PI-> PP	0.093	0.095	0.049	0.028	0.228	2.033	0.048	Supported
H10: IPMP->PI->PP	0.151	0.145	0.072	0.051	0.349	2.085	0.038	Supported
H11: ICx IDS -> PP	0.107	0.105	0.033	0.049	0.175	3.243	0.001	Supported
H12: ICxATU ->PP	0.049	0.044	0.075	-0.107	0.170	0.646	0.518	Not Supported
H13: ICxIPMP->PP	-0.122	-0.115	0.058	-0.213	-0.015	2.103	0.036	Supported

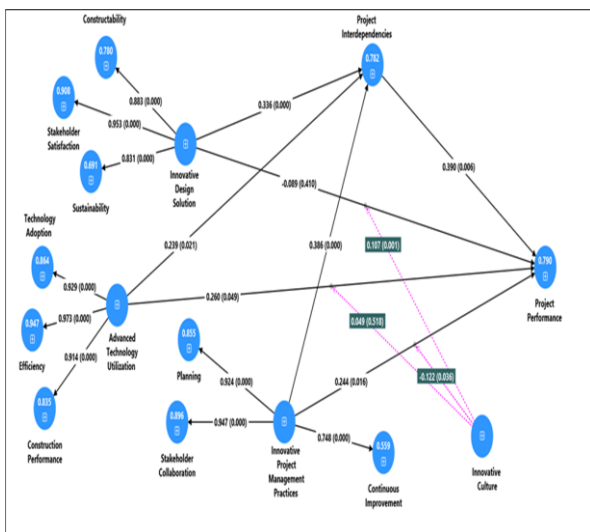


Figure 5. Structural model with path coefficient beta values and p-values from Bootstrapping test

5. Discussion

The study aims to provide an understanding of projects innovation in the Oman construction industry and the relationship between the elements of the innovation and project performance, based on the literature. The study identifies drivers, enablers, barriers, and benefits that exist in context and establishes a comparison with the previous literature. The study findings suggest a positive association between innovation drivers such as cost/time savings, clients' demand, and project management effectiveness, which agrees with [24] who consider cost efficiency a driver. However, this is inconsistent with [34] classification, in which drivers are grouped under environmental tension, technology, transfer of knowledge, and boundary spanning. While [34] model is more general and considers systemic and collaborative aspects, the Oman study has a more

operational angle, which may have been due to the sector's more practical, business-oriented concerns. This divergence reveals this category of analytical tension between the general innovation system perspectives and context-oriented approaches to innovations in developing countries.

Also, innovation enablers – leadership, incentives, and organisational support – correlate with [18], but unlike [37], it also goes beyond motivation, time, and resources. The study also reveals that Oman's construction sector appreciates external engagement and learning as potential enablers of innovation. This aligns with current literature on stakeholder management [25] but departs from literature that paints clients as subordinate in hierarchical industries. On the other hand, challenges like financial constraints and project fragmentation also align with the systemic factors that are economic volatility and industry fragmentation by [27]. However, this study identifies new barriers such as a lack of efficient project management and clients' lack of trust in innovation, which are not as much discussed in the Western literature. This explains why the region is still in the early stages of innovation and still depends on conventional practices, which makes institutions cautious.

Further, the expounded advantages of innovation, such as stakeholder relations and competitive advantage, build upon [26] conclusions regarding customer satisfaction and the environment. In positioning stakeholder engagement as the direct gain, the study implicitly argues against the transactional idea of innovation and for relational improvement of project results. This is in line with [29] definition of innovation and linkage with organizational creativity; nonetheless, the Oman study is more specific in terms of construction industry outcomes.

Additionally, the second objective focuses on the moderating impact of the innovation culture, and the results show a powerful positive relationship between adopting innovation and project success. That said, the extremity of the correlation places cultural factors as important drivers into focus. Few studies report such strong effects; for instance, [17] established a moderate positive correlation between culture and innovation in service industries. It can be argued that the Oman construction industry may be culturally homogenous or has some method acting biases, such as self-generated high correlation. The identified

drivers, such as cost reduction and technological competition, align with the study of [30] in an emerging economy, where diversification pressure increases the innovation pressure. However, excluding factors such as institutional environment or international collaborations, which are crucial in the context of the GCC region, makes one wonder about cultural moderators' uniqueness as the only success enablers.

Furthermore, this study has adopted projects interdependencies as a benefit, which shifts the paradigm from the transactional approach advocated by [24]. Also, including new enablers in more than [13] model shows the development of the concept of innovation actors in stiff sectors. However, regression and correlation analyses may distort the causal relationships, as some authors pointed out [12] and stress the necessity of using mixed methods in innovation research. However, it differs from Western studies in that while [10] focus on the systemic and cultural enablers, Oman's context is more inclined to the operation drivers due to its developmental nature. This is consistent with [28] study on GCC construction, where first-order efficiency improvements hide innovation costs.

Overall, the present study adds to the literature by establishing the projects innovation in the context of Oman's construction industry and the extent to which it aligns or deviates from the findings in the literature. It supports the findings on mediating role of projects interdependencies elsewhere, but its focus on Advanced technologies utilization and innovative project management practices contributes to the literature in the sector. However, the strong cultural moderation effect should be investigated in more detail. It would be interesting to see how external variables affect this effect and how the methods used in the research can also influence the results. Thus, the study provides a theoretical and empirical reference point for policy to promote innovation in such economies.

6. Conclusion

This study highlights the importance of adopting proper project innovation practices in construction projects in Oman. The study emphasized that the innovative design solutions and project interdependencies, positively relate to project success, while innovation culture also plays the role of a moderator. This study identified that despite Oman's high dependence on the

hydrocarbon sector, the challenging task will be to implement advanced technologies and modern project management methodologies (i.e., Agile practices, Disruptive digital tools) and an organizational culture that supports an innovation system to minimize the risks and enhance the project performance to achieve the diversification goals. Problems like a lack of funds or integration of practices emphasize the need for structural changes. The study findings have significant implications for policymakers and industry actors to focus on investments in technology, capacity, and cooperation to establish innovation as a lasting development objective for the Oman construction sector and build its ability to respond to future challenges.

Declarations

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7. Conclusions

The incremental conductance based maximum power point tracking algorithm is used for obtaining optimal power from the solar plants and this model is equipped with the STATCOM including harmonic filters. The integration of solar plant is done with the help of the coupling transformer and switches. The output voltage harmonics of the system have been analysed with the help of the FFT window and it is recorded as very high value of about 59%, which is highly undesirable according to IEEE standards. The STATCOM along with the Harmonic filters have been used to mitigate these harmonics. The effect of the power quality compensators on the mitigation of output voltage harmonics have been analysed with the FFT window and is recorded as very low value of the order less than 2% which is highly accepted according to IEEE standards and it proves the effectiveness of STATCOM along with

harmonic filters on mitigation of harmonics in power system.

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