PROJECT MANAGEMENT

Critical Success Factors for Project Management Excellence in Infrastructure Projects: An Empirical Study

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Abstract

Indian infrastructure projects continue to finish late and over budget even as public capital spending rises. This study asks which critical success factors (CSFs) build project management excellence (PME) on such projects, and whether that excellence carries through to infrastructure project success (IPS). Six CSFs were drawn from the literature: project manager competency, top management support, stakeholder engagement and communication, planning and scheduling effectiveness, risk management practices, and contractual and procurement clarity. A structured questionnaire collected 312 usable responses from professionals on road, metro, bridge, water and power projects. Partial least squares structural equation modelling (PLS-SEM) in SmartPLS 4 with 5,000 bootstrap subsamples tested the model. Five of the six CSFs had significant positive effects on PME, with project manager competency the strongest ($\beta = 0.285$, $p < 0.001$). Contractual and procurement clarity was not significant ($\beta = 0.058$, $p = 0.113$). Together the CSFs explained 61.0% of the variance in PME, and PME explained 33.0% of the variance in IPS ($\beta = 0.574$, $p < 0.001$). PME mediated the effects of the five significant CSFs on IPS. An importance-performance map analysis identified stakeholder engagement and risk management as the priorities for improvement, since they combine high importance with the lowest performance in the model.

Keywords: critical success factors; project management excellence; infrastructure projects; PLS-SEM; project success; India

1 Introduction

Infrastructure spending in India has grown sharply, yet delivery has not kept pace. A government monitoring report cited by Kumar et al. (2023) found that 661 of 1,505 central sector projects costing INR 150 crore or more were delayed and 386 reported cost overruns. Doloi et al. (2012) traced such delay to weak site management, slow client decisions, poor coordination and contractual disputes, problems that sit in the management system of a project rather than in its engineering.

Megaprojects worldwide show the same pattern. Flyvbjerg (2014) described an "iron law" under which large projects run over budget and over time, again and again. Denicol et al. (2020) reviewed 86 papers on poor megaproject performance and found that no single factor explained failure; several interrelated causes acted together.

Research on critical success factors starts from the observation that a few conditions, managed well, decide whether a project meets its goals. Pinto and Slevin (1987) identified ten such factors et al. (1996) grouped factors by project, manager, organisation and environment, and Chan et al. (2004) did the same for construction. Most of this work ranks factors by mean score or relative importance index. It seldom tests how they work together, or through what mechanism they reach the outcome.

The present study proposes that CSFs do not act on project success directly. They first build a capability, project management excellence, which then carries their effect to the outcome. Cooke-Davies (2002) drew a similar line between project management success, judged on time, cost and quality, and project success, judged against the overall objectives of the project.

Three questions follow: which CSFs significantly influence PME on Indian infrastructure projects, whether PME influences IPS, and whether PME mediates the link between the CSFs and IPS. PLS-SEM on data from 312 practitioners answers them, and an importance-performance map analysis (IPMA) shows managers which factors matter most and which are managed worst.

2 Literature Review and Hypotheses

2.1 Project success and project management excellence

For a long time project success meant delivery on time, within budget and to specification. Atkinson (1999) called these criteria "two best guesses and a phenomenon", because the time and cost targets are estimates made when least is known and quality is a judgement that shifts with the observer; benefits to the organisation and its stakeholders, he argued, belong beside them. Ika and Pinto (2022) went further and judged a project on plan success, business case success, green efficacy and the shared perception of key stakeholders. Pinto et al. (2022) noted that success stays contested because different parties value different outcomes at different times.

Infrastructure raises the stakes, since the client is usually a public body and the end users are citizens. The present study therefore measures IPS on five indicators: schedule, budget, quality and safety, client and user satisfaction, and delivery of the intended public benefit. The choice follows the broader criteria compiled by Kiani Mavi et al. (2025), whose review grouped construction success research into clusters for infrastructure and public projects, risk and knowledge management, and contractor and procurement management.

Project management excellence is treated here as the maturity and consistency of management practice on a project: standard processes, reliable controls, use of earlier lessons, and team discipline in following agreed procedures. PME is thus a property of how the project is run, distinct from both its enablers and its outcomes.

2.2 Critical success factors

Table 1 summarises representative studies on CSFs. Six factors recur across them and form the exogenous constructs of this study.

Table 1. Summary of selected studies on critical success factors and project success.

Study	Context	Main finding	Method
Pinto & Slevin (1987)	Project implementation, several industries	Ten CSFs, including top management support, schedule and plans, client consultation, personnel and technical tasks	Factor development
Belassi & Tukel (1996)	Projects in several sectors	Factors grouped by project, manager and team, organisation and external environment	Conceptual framework, survey
Cooke-Davies (2002)	Large projects in many organisations	Project management success differs from project success; consistent practice is linked to delivery	Empirical, benchmarking

Study	Context	Main finding	Method
Chan et al. (2004)	Construction projects	Project-related, procedural, management action, human and external factor groups	Literature-based framework
Doloi et al. (2012)	Indian construction	Site management, coordination, client decisions and contractual relationships explain delay	Questionnaire, factor analysis
Gunduz & Almuajebh (2020)	Construction projects	40 success factors in seven categories weighted for sustainable project management	AHP
Denicol et al. (2020)	Megaprojects	18 causes and 54 cures of poor performance under six themes	Systematic review
Kumar et al. (2023)	Large Indian construction projects	Practitioners name far fewer CSFs than surveys list	Semi-structured interviews
Kiani Mavi et al. (2025)	Construction projects	Success criteria cluster around infrastructure and public projects, risk and knowledge, and contractors and procurement	Bibliometric review

Project manager competency. Most project decisions pass through the project manager. Pinto and Slevin (1987) counted technical tasks, client consultation and personnel matters among the manager's duties, and Chan et al. (2004) placed experience, coordinating ability and leadership in their human-related group. From interviews with senior managers on large Indian projects, Kumar et al. (2023) found that practitioners name far fewer CSFs than surveys list and attend most to those they can act on during execution.

H1: Project manager competency has a significant positive effect on project management excellence.

Top management support. Senior management controls budgets, staff and the authority to settle disputes between departments. Pinto and Slevin (1987) found this support to be one of the strongest predictors of implementation success, and Belassi and Tukel (1996) placed it among the organisational factors that shape the project manager's room for action.

H2: Top management support has a significant positive effect on project management excellence.

Stakeholder engagement and communication. Infrastructure touches landowners, utility agencies, environmental regulators, local governments and the travelling public. Denicol et al. (2020) treated engagement with institutions and communities as one of the main cures for poor megaproject performance. Clear channels between client, consultant and contractor also reduce the rework and waiting that Doloi et al. (2012) linked to delay on Indian sites.

H3: Stakeholder engagement and communication has a significant positive effect on project management excellence.

Planning and scheduling effectiveness. A realistic baseline, a work breakdown prepared before mobilisation, and regular tracking against that baseline give managers the information to act early. Chan et al. (2004) grouped planning among the management actions that predict success. Gunduz and Almuajebh (2020) collected 40 factors from earlier work into seven groups, and weighted them with the analytic hierarchy process; planning appears among the project management factors in their scheme.

H4: Planning and scheduling effectiveness has a significant positive effect on project management excellence.

Risk management practices. Flyvbjerg (2014) attributed much of the overrun on megaprojects to optimism bias at approval stage, when risks are understated so that the project can be sanctioned. A working risk register, named risk owners and contingency sized to identified risks are the practical counter to that bias. Denicol et al. (2020) listed risk and uncertainty as one of their six themes.

H5: Risk management practices have a significant positive effect on project management excellence.

Contractual and procurement clarity. Ambiguous scope, unfair payment terms and slow processing of change orders are frequent sources of dispute. Doloi et al. (2012) found contractual relationships among the main delay factors in India, and Chan et al. (2004) placed procurement among procedural factors. A clear contract should let managers spend time on delivery rather than on claims.

H6: Contractual and procurement clarity has a significant positive effect on project management excellence.

2.3 From excellence to success

Better management practice should show up in better outcomes. Cooke-Davies (2002) linked consistent practice with delivery to time and cost, and Ika and Pinto (2022) argued that plan success, the dimension closest to management practice, is a precondition for the wider dimensions of success.

H7: Project management excellence has a significant positive effect on infrastructure project success.

If H1 to H7 hold, PME sits between the CSFs and IPS: the factors build the capability, and the capability produces the result. Figure 1 shows the resulting framework.

H8 (a to f): Project management excellence mediates the effect of each critical success factor on infrastructure project success.

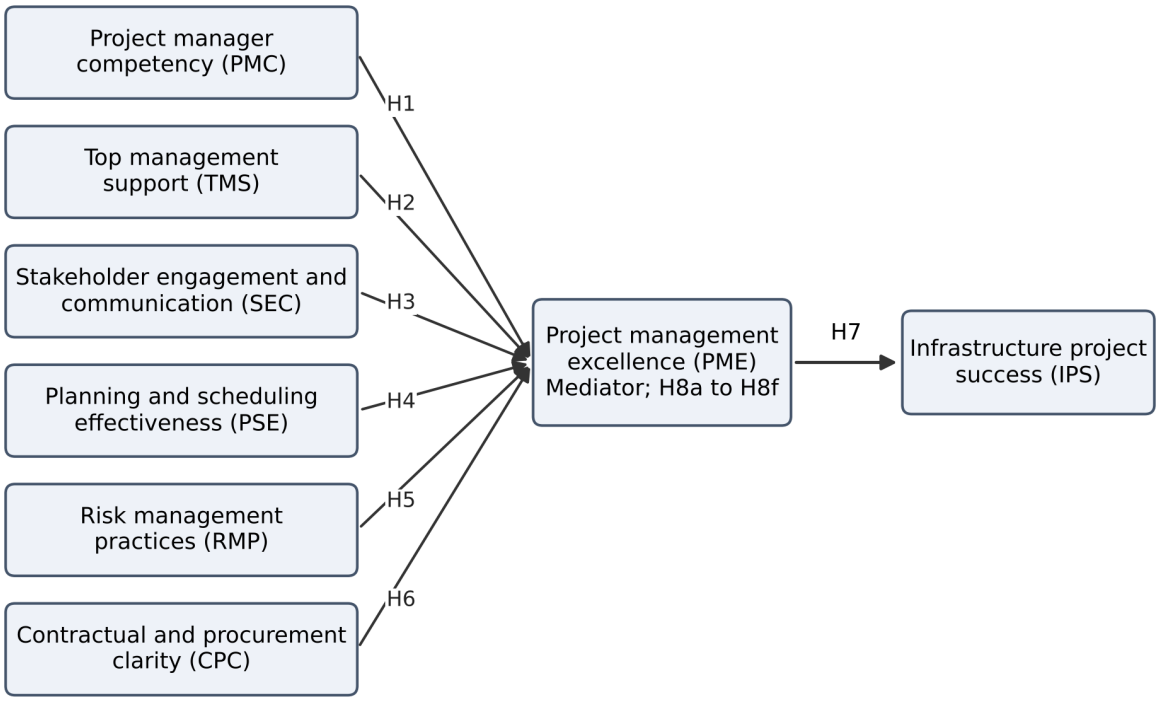

Figure 1. Conceptual framework of the study. Developed from the literature reviewed. Arrows denote hypothesised positive effects; H8a to H8f denote the indirect effects of each CSF on IPS through PME.

3 Research Methodology

3.1 Research design and population

The study follows a quantitative, cross-sectional survey design. Respondents were project managers and engineers-in-charge, site and planning engineers, consultant staff and client-side officials with at least two years on a road, metro or rail, bridge, water supply and sewerage, or power project in India. Each answered with reference to the project on which they had worked most recently.

3.2 Instrument

The questionnaire recorded the respondent's role, experience, project type and ownership mode, followed by 34 statements on the eight constructs, rated from 1 (strongly disagree) to 5 (strongly agree). Items were adapted from the sources in Table 3 and reworded for infrastructure. Three academics and two practising project managers reviewed content validity, and a pilot with 30 respondents, excluded from the main analysis, led to minor wording changes.

3.3 Sampling and data collection

Purposive sampling with referrals reached respondents through professional networks, project sites and consultancy firms. Of 450 questionnaires distributed in print and online, 341 were returned and 312 were usable, a response rate of 69.3%. G*Power gives a minimum sample of 146 for six predictors, $f^2 = 0.15$, $\alpha = 0.05$ and power of 0.95, so the sample is adequate. Table 2 profiles the respondents.

Table 2. Profile of respondents (n = 312).

Variable	Category	Frequency	Percent
Role	Project manager / engineer-in-charge	84	26.92
	Site / planning engineer	109	34.94
	Consultant (PMC) staff	63	20.19
	Client-side official	56	17.95
Experience	Less than 5 years	58	18.59
	5 to 10 years	117	37.50
	11 to 15 years	79	25.32
	More than 15 years	58	18.59
Project type	Roads and highways	121	38.78
	Metro and rail	72	23.08
	Bridges and flyovers	54	17.31
	Water supply and sewerage	41	13.14
	Power and others	24	7.69
Ownership	Public (EPC / item rate)	187	59.94
	Public-private partnership	78	25.00
	Private	47	15.06

3.4 Analytical approach

PLS-SEM suits the study because its aim is prediction and explanation of target constructs, the model includes a mediator, and the method does not require multivariate normal data (Hair et al., 2019). The model was estimated in SmartPLS 4 (version 4.1.1.2) using the path weighting scheme, and significance was tested with 5,000 bootstrap subsamples, percentile confidence intervals and two-tailed tests at the 0.05 level. Following Hair et al. (2019), the measurement model was assessed before the structural model.

Because predictors and outcomes came from the same respondents at one time, common method bias was a concern. Following Podsakoff et al. (2003), anonymity was assured, constructs were placed in separate sections, and outcome items followed predictor items. In the full collinearity test of Kock (2015), all construct-level VIF values lay between 1.312 and 2.842, below 3.3, so common method bias is unlikely to distort the results.

4 Data Analysis and Results

4.1 Descriptive statistics

Figure 2 compares construct means. Project manager competency received the highest rating (M = 3.74, SD = 0.86) and risk management practices the lowest (M = 3.18, SD = 0.98), just below stakeholder engagement and communication (M = 3.29, SD = 0.99). PME (M = 3.41, SD = 0.93) and IPS (M = 3.34, SD = 0.94) sat near the middle of the scale.

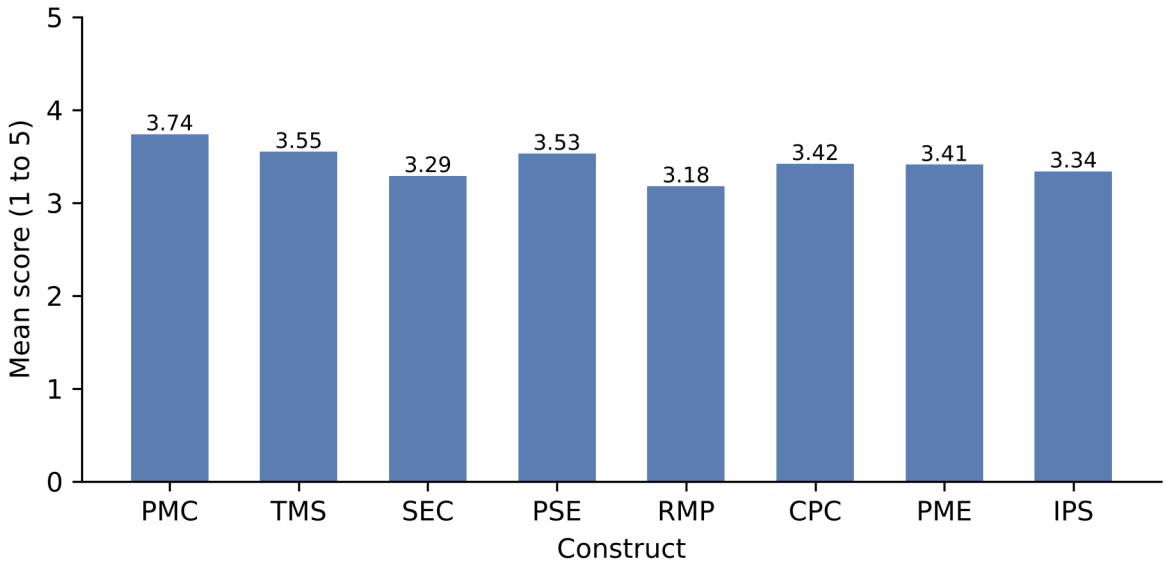

Figure 2. Mean scores of the study constructs (five-point scale).

4.2 Measurement model

Tables 3 and 4 report the measurement model, and Figure 3 shows the SmartPLS output of the PLS algorithm with outer loadings, path coefficients and R^2 values. Outer loadings ranged from 0.779 to 0.890, above 0.708, so all indicators were retained, and no indicator VIF exceeded 2.884. Cronbach's alpha (0.832 to 0.896), rho_A (0.835 to 0.899) and composite reliability (0.888 to 0.924) all lay between 0.70 and 0.95, which shows internal consistency without redundant items. With AVE between 0.666 and 0.749, each construct explains more than half the variance of its indicators.

Table 3. Measurement items, sources and outer loadings.

Code	Item statement	Loading	VIF
Project manager competency (PMC); adapted from Pinto & Slevin (1987); Chan et al. (2004)			
PMC1	The project manager has adequate technical knowledge of infrastructure works.	0.824	1.759
PMC2	The project manager takes timely decisions when site problems arise.	0.805	1.718
PMC3	The project manager coordinates designers, contractors and consultants well.	0.780	1.727
PMC4	The project manager motivates the project team to meet milestones.	0.858	2.128
Top management support (TMS); adapted from Pinto & Slevin (1987); Belassi & Tukel (1996)			
TMS1	Senior management releases resources when the project needs them.	0.827	2.020
TMS2	Senior management backs the project manager's decisions.	0.890	2.546
TMS3	Senior management reviews project progress at regular intervals.	0.867	2.471
TMS4	Senior management resolves inter-departmental issues quickly.	0.877	2.457
Stakeholder engagement and communication (SEC); adapted from Doloi et al. (2012); Denicol et al. (2020)			
SEC1	Affected communities are consulted before major works begin.	0.831	2.038
SEC2	Approving authorities receive timely and accurate project information.	0.881	2.497
SEC3	Communication channels among project parties are clearly defined.	0.850	2.211

Code	Item statement	Loading	VIF
SEC4	Stakeholder concerns are recorded and resolved within an agreed time.	0.870	2.291
Planning and scheduling effectiveness (PSE); adapted from Chan et al. (2004); Gunduz & Almuajebh (2020)			
PSE1	The baseline schedule is realistic and based on site conditions.	0.831	1.866
PSE2	Work breakdown and resource plans are prepared before execution.	0.836	1.905
PSE3	Progress is tracked against the baseline at fixed intervals.	0.781	1.634
PSE4	Schedule deviations lead to corrective action without delay.	0.814	1.771
Risk management practices (RMP); adapted from Flyvbjerg (2014); Denicol et al. (2020)			
RMP1	Project risks are identified at the planning stage.	0.862	2.251
RMP2	A risk register is maintained and updated during execution.	0.868	2.387
RMP3	Contingency allowances are set for major risks.	0.871	2.309
RMP4	A risk owner is assigned for each high-priority risk.	0.815	1.887
Contractual and procurement clarity (CPC); adapted from Chan et al. (2004); Doloi et al. (2012)			
CPC1	Contract documents define scope and responsibilities clearly.	0.844	2.060
CPC2	Payment terms in the contract are fair and are followed.	0.825	1.889
CPC3	Change orders are processed through a defined procedure.	0.827	2.030
CPC4	The tendering process selects capable contractors.	0.849	1.915
Project management excellence (PME); adapted from Cooke-Davies (2002); Ika & Pinto (2022)			
PME1	Project management processes on this project are standardised.	0.859	2.416
PME2	Lessons from earlier projects are applied on this project.	0.844	2.295
PME3	Project controls give reliable information for decisions.	0.839	2.260
PME4	Team members follow the agreed management procedures.	0.839	2.214
PME5	Management practice on this project compares well with industry benchmarks.	0.779	1.843
Infrastructure project success (IPS); adapted from Atkinson (1999); Ika & Pinto (2022); Kiani Mavi et al. (2025)			
IPS1	The project was (or is being) completed within the approved schedule.	0.879	2.884
IPS2	The project was (or is being) completed within the sanctioned budget.	0.845	2.278
IPS3	The work meets the specified quality and safety standards.	0.783	1.836
IPS4	The client and end users are satisfied with the outcome.	0.828	2.274
IPS5	The project delivers its intended public benefit.	0.873	2.647

Note. Five-point scale (1 = strongly disagree, 5 = strongly agree). All loadings exceed 0.708 and all VIF values are below 3.3 (Hair et al., 2019).

Table 4. Construct reliability and convergent validity.

Construct	Alpha	rho_A	CR	AVE
Project manager competency (PMC)	0.833	0.839	0.889	0.668
Top management support (TMS)	0.889	0.897	0.923	0.749
Stakeholder engagement and communication (SEC)	0.880	0.884	0.918	0.736

Construct	Alpha	rho_A	CR	AVE
Planning and scheduling effectiveness (PSE)	0.832	0.835	0.888	0.666
Risk management practices (RMP)	0.877	0.880	0.915	0.730
Contractual and procurement clarity (CPC)	0.857	0.864	0.903	0.699
Project management excellence (PME)	0.889	0.891	0.918	0.693
Infrastructure project success (IPS)	0.896	0.899	0.924	0.709

Note. CR = composite reliability (rho_c); AVE = average variance extracted. Thresholds: alpha, rho_A and CR between 0.70 and 0.95; AVE above 0.50.

Discriminant validity was checked in two ways. Under the Fornell and Larcker (1981) criterion, the square root of each construct's AVE should exceed its correlations with other constructs. Table 5 shows that this condition held for every construct. The heterotrait-monotrait ratio (HTMT) proposed by Henseler et al. (2015) is a stricter test, and the upper triangle of Table 5 shows that the highest HTMT value was 0.642, between project manager competency and PME, well below the conservative threshold of 0.85. Discriminant validity is therefore established.

Table 5. Discriminant validity: Fornell and Larcker criterion (lower triangle) and HTMT ratios (upper triangle).

	PMC	TMS	SEC	PSE	RMP	CPC	PME	IPS
PMC	*0.817*	0.311	0.365	0.393	0.344	0.370	0.642	0.439
TMS	0.272	*0.865*	0.292	0.322	0.376	0.312	0.521	0.371
SEC	0.315	0.263	*0.858*	0.449	0.358	0.414	0.598	0.413
PSE	0.331	0.280	0.385	*0.816*	0.419	0.387	0.628	0.404
RMP	0.297	0.331	0.316	0.359	*0.854*	0.391	0.583	0.348
CPC	0.311	0.277	0.363	0.327	0.343	*0.836*	0.475	0.329
PME	0.556	0.464	0.532	0.542	0.517	0.420	*0.832*	0.641
IPS	0.383	0.331	0.369	0.351	0.309	0.290	0.574	*0.842*

Note. Italic diagonal values are square roots of AVE; values below the diagonal are latent variable correlations; values above the diagonal are HTMT ratios, all below the conservative threshold of 0.85 (Henseler et al., 2015).

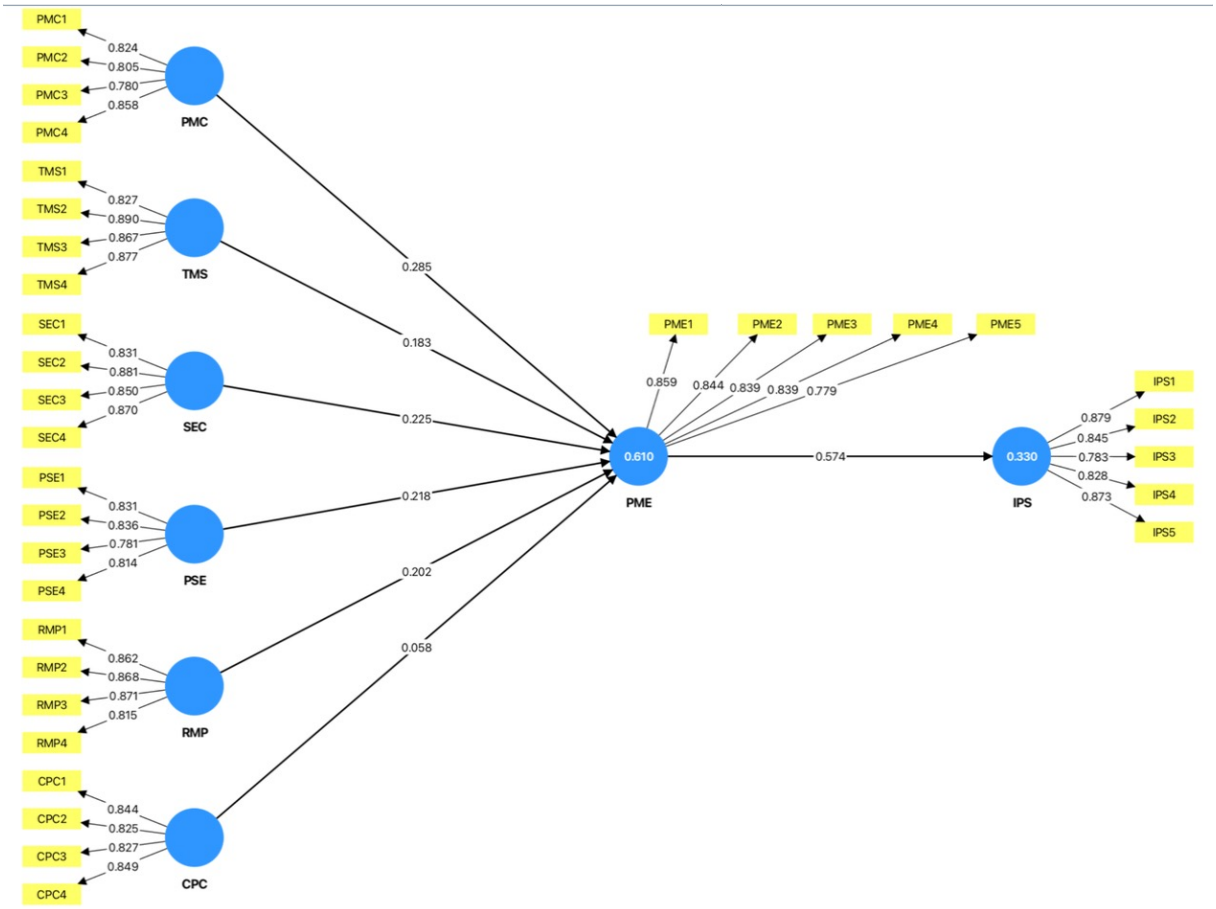

Figure 3. Measurement and structural model estimated with the PLS-SEM algorithm in SmartPLS 4. Indicator arrows show outer loadings, construct arrows path coefficients, and circles R^2.

4.3 Structural model

Inner VIF values for the predictors of PME ranged from 1.217 to 1.351, so collinearity does not bias the estimates. The six CSFs explained 61.0% of the variance in PME (adjusted $R^2 = 0.602$), and PME explained 33.0% of the variance in IPS (adjusted $R^2 = 0.328$). PLSpredict with 10 folds and 10 repetitions gave Q^2predict values of 0.593 for PME and 0.260 for IPS, both above zero, confirming predictive relevance.

Table 6 and the bootstrapping output in Figure 4 present the hypothesis tests. Project manager competency had the strongest effect on PME ($\beta = 0.285$, $t = 7.233$, $p < 0.001$), supporting H1. Stakeholder engagement and communication ($\beta = 0.225$, $p < 0.001$), planning and scheduling effectiveness ($\beta = 0.218$, $p < 0.001$), risk management practices ($\beta = 0.202$, $p < 0.001$) and top management support ($\beta = 0.183$, $p < 0.001$) also had significant positive effects, so H3, H4, H5 and H2 are supported. Contractual and procurement clarity did not reach significance ($\beta = 0.058$, $t = 1.586$, $p = 0.113$) and its 95% confidence interval included zero; H6 is not supported. PME had a strong positive effect on IPS ($\beta = 0.574$, $t = 14.984$, $p < 0.001$), supporting H7.

Table 6. Results of hypothesis testing (direct effects).

Hyp.	Path	β	SD	t	p	95% CI	Decision
H1	PMC → PME	0.285	0.039	7.233	< .001	[0.206, 0.361]	Supported
H2	TMS → PME	0.183	0.040	4.586	< .001	[0.104, 0.263]	Supported

Hyp.	Path	β	SD	t	p	95% CI	Decision
H3	SEC → PME	0.225	0.041	5.458	< .001	[0.143, 0.305]	Supported
H4	PSE → PME	0.218	0.040	5.407	< .001	[0.137, 0.295]	Supported
H5	RMP → PME	0.202	0.040	5.046	< .001	[0.122, 0.280]	Supported
H6	CPC → PME	0.058	0.037	1.586	.113	[-0.011, 0.132]	Not supported
H7	PME → IPS	0.574	0.038	14.984	< .001	[0.495, 0.647]	Supported

Note. Bootstrapping with 5,000 subsamples, two-tailed test; CI = percentile bootstrap confidence interval; values from SmartPLS 4.

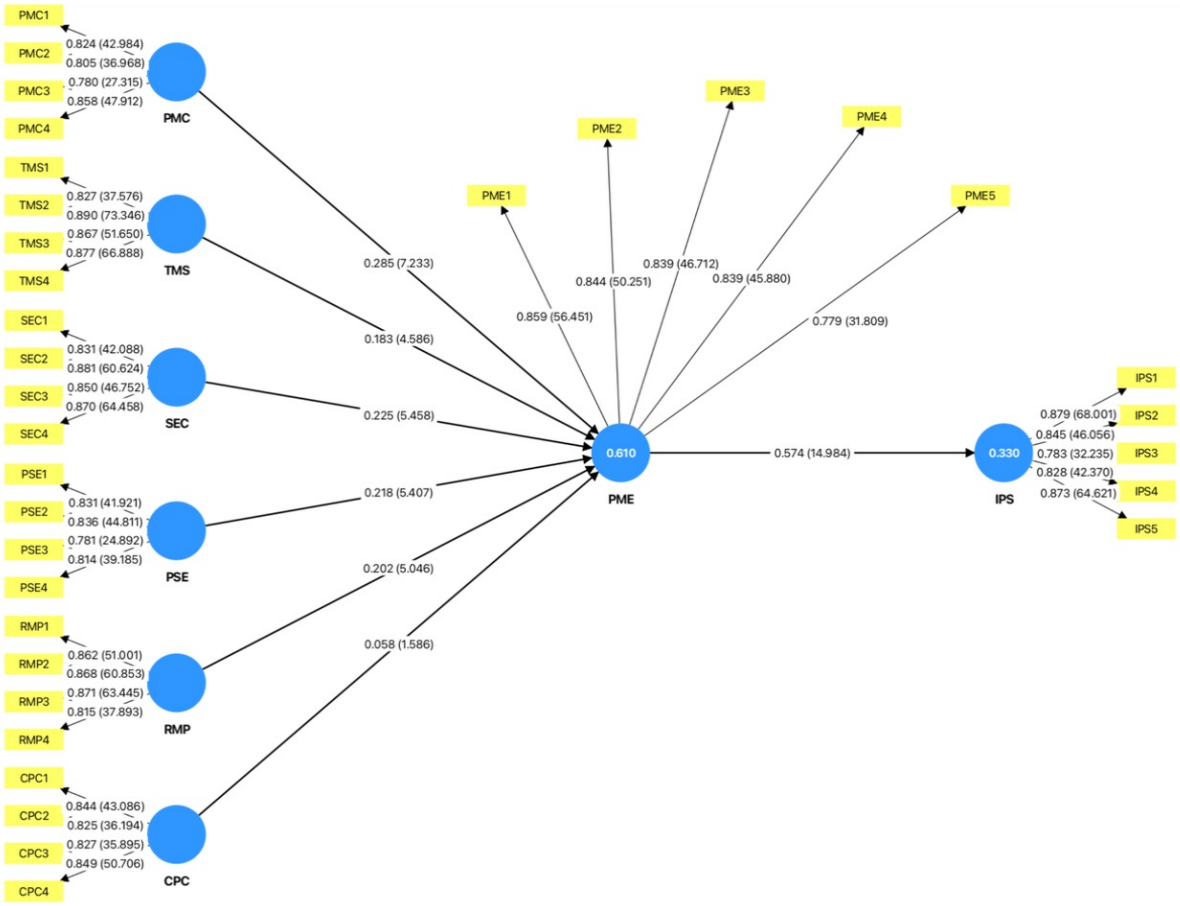

Figure 4. Bootstrapping results in SmartPLS 4: coefficients with t values. 5,000 subsamples; t > 1.96 is significant at p < .05; CPC to PME (t = 1.586) is not significant.

PME had a large effect on IPS (f^2 = 0.492). Among the CSFs, only project manager competency had a medium effect on PME (f^2 = 0.166), and the effect of contractual and procurement clarity was negligible (f^2 = 0.007).

4.4 Mediation analysis

Specific indirect effects were tested with the same bootstrap procedure (Table 7). Five were significant, with confidence intervals that excluded zero. The largest ran from project manager competency through PME to IPS (β = 0.164, t = 6.593, p < 0.001), while the indirect path from contractual and procurement clarity was not significant (β = 0.033, p = 0.116). H8a to H8e are therefore supported and H8f is not. Since the model has no direct paths from the CSFs to IPS, the results show that PME transmits the CSF effects; separating partial from full mediation would require those paths.

Table 7. Specific indirect effects through project management excellence.

Hyp.	Indirect path	β	SD	t	p	95% CI	Decision
H8a	PMC → PME → IPS	0.164	0.025	6.593	< .001	[0.115, 0.212]	Supported
H8b	TMS → PME → IPS	0.105	0.024	4.352	< .001	[0.060, 0.154]	Supported
H8c	SEC → PME → IPS	0.129	0.025	5.092	< .001	[0.080, 0.180]	Supported
H8d	PSE → PME → IPS	0.125	0.025	5.015	< .001	[0.077, 0.174]	Supported
H8e	RMP → PME → IPS	0.116	0.024	4.785	< .001	[0.068, 0.164]	Supported
H8f	CPC → PME → IPS	0.033	0.021	1.573	.116	[-0.007, 0.076]	Not supported

Note. Bootstrapping with 5,000 subsamples.

4.5 Importance-performance map analysis

IPMA sets the total effect of each construct on IPS (importance) against its mean latent score rescaled from 0 to 100 (performance), as Table 8 and the SmartPLS map in Figure 5 show. PME is by far the most important construct (0.574; performance 60.29). Among the CSFs, project manager competency is both the most important (0.164) and the best performing (68.58). Stakeholder engagement and communication (0.129; 57.25) and risk management practices (0.116; 54.43) pair above-average importance with the lowest performance in the model, so they offer the greatest return on improvement effort. Contractual and procurement clarity matters little for IPS here (0.033).

Table 8. Importance-performance map for infrastructure project success.

Construct	Importance (total effect)	Performance (0 to 100)
Project manager competency (PMC)	0.164	68.58
Top management support (TMS)	0.105	63.81
Stakeholder engagement and communication (SEC)	0.129	57.25
Planning and scheduling effectiveness (PSE)	0.125	63.22
Risk management practices (RMP)	0.116	54.43
Contractual and procurement clarity (CPC)	0.033	60.39
Project management excellence (PME)	0.574	60.29

Note. Target construct: IPS (performance = 58.49).

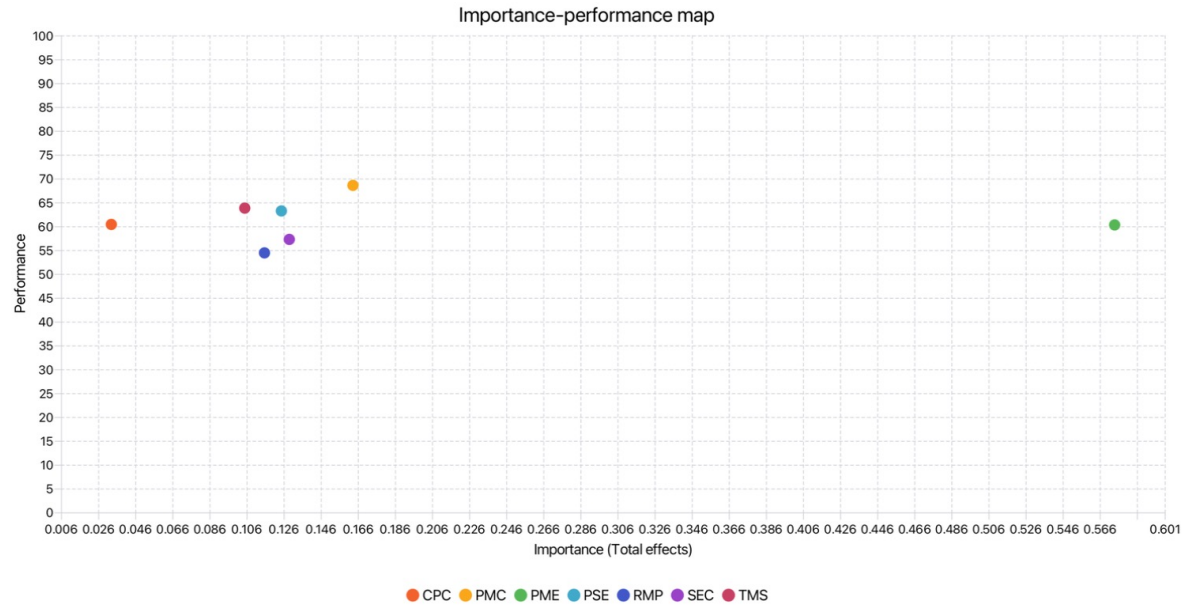

Figure 5. Importance-performance map for infrastructure project success (SmartPLS 4). Importance is the total effect on IPS; performance is the rescaled (0 to 100) latent variable score.

5 Discussion

The central result is that PME is the channel through which most CSFs reach the outcome of an infrastructure project. Five of the six factors raised PME, and PME in turn explained a third of the variance in success. This gives an empirical test in Indian infrastructure to the distinction Cooke-Davies (2002) drew between the success of management and of the project, and it fits the view of Denicol et al. (2020) that several interrelated factors, not one, drive performance.

Project manager competency emerged as the strongest factor, in line with Pinto and Slevin (1987), who placed the manager's handling of technical, client and personnel tasks at the core of implementation success, and with the execution focus of Indian practitioners reported by Kumar et al. (2023).

Stakeholder engagement and planning had almost equal effects, consistent with the coordination failures behind Indian delays (Doloi et al., 2012) and with the weight given to planning by Chan et al. (2004) and Gunduz and Almuajebh (2020). The IPMA shows what path coefficients alone miss: stakeholder engagement is important but performed poorly, which makes it a practical priority.

Risk management showed a similar profile: a significant effect on PME but the lowest performance score in the model. Flyvbjerg (2014) traced overruns to risks understated at approval, and the low ratings here suggest that risk registers and contingency planning remain formal exercises on many Indian projects. Top management support had a smaller significant effect, in line with Pinto and Slevin (1987) and Belassi and Tukel (1996).

The non-significant effect of contractual and procurement clarity needs care. It does not mean contracts are unimportant, since Doloi et al. (2012) found contractual relationships among the main causes of delay. One explanation is that public infrastructure contracts in India follow standard formats, so the factor varies little across projects and adds little once competency, planning and risk practice are known. Contract clarity may also act through dispute avoidance, a path future studies should test.

The link from PME to IPS (β = 0.574) was the strongest in the model, and PME raised all five success indicators together, which supports the multidimensional view of success in Atkinson (1999) and Ika and Pinto (2022). An R^2 of 0.330 still leaves much of the variance in success outside management practice. Land acquisition, political cycles and funding flows lie beyond the project manager's control (Pinto et al., 2022).

6 Conclusion and Implications

6.1 Conclusion

PLS-SEM on 312 responses showed that five of the six CSFs raise PME on Indian infrastructure projects, with contractual and procurement clarity the exception. PME strongly predicted IPS and carried the effects of the five significant CSFs to it, and stakeholder engagement and risk management are where effort would pay most.

6.2 Theoretical implications

The study tests CSFs jointly in one structural model rather than ranking them, positions PME as the mediating capability that turns factors into outcomes, and measures success on a multidimensional scale that includes public benefit (Ika and Pinto, 2022; Kiani Mavi et al., 2025).

6.3 Managerial implications

Owners and contractors should invest first in selecting and developing project managers for decisions under site uncertainty and multi-party coordination. Client agencies should adopt formal stakeholder engagement plans with named liaison officers, and risk registers should be reviewed at each progress meeting with named owners and contingency tied to identified risks.

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