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A Structural Equation Modelling Approach to Developing a Project Delivery Performance Framework for the Indian Steel Sector

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Abstract
The aim of this study is to examine the key organizational and managerial factors influencing Project Delivery Performance (PDP) in the Indian steel sector and to develop an empirically validated framework using Structural Equation Modelling (SEM). A quantitative, cross-sectional research design was adopted and primary data were collected through a structured questionnaire from 330 project professionals drawn from public and private sector steel companies. Partial Least Squares–SEM was employed to test direct and indirect relationships among governance, leadership, risk management, resource planning, technology adoption, stakeholder engagement and PDP, with Project Management Capability and Organizational Agility as mediating variables. The findings reveal that the proposed model explains a substantial proportion of variance in PDP, highlighting the critical mediating role of organizational agility and selective direct effects of leadership and risk management practices. The study offers important theoretical contributions by extending multidimensional PDP frameworks and provides practical implications for managers by emphasizing capability development, agile practices and robust governance mechanisms to enhance project delivery effectiveness in the steel industry.

Keywords: *Project Delivery Performance; Structural Equation Modelling; Project Management Capability; Project Governance; Indian Steel Sector*

Introduction

The Indian steel sector is undergoing rapid modernization as part of the country's ambitious trajectory to become a $5 trillion economy in the coming years. As a backbone of economic growth, Steel underpins critical sectors such as infrastructure, transportation, housing, bridges, flyovers, urbanisation, industrialisation, construction, energy, Electricity, Gas & Water Pipelines, defence and manufacturing. As a result surging demand for Steel, the industry is witnessing unprecedented expansion and modernization activities from current capacity of 150 MTPA to scale it up to 300 MTPA by 2030 (National Steel Policy 2017). Which is necessitating complex, large-scale project management across both public and private enterprises.

The steel companies undertaking large-scale capital, expansion and modernization projects characterized by high investment, technological complexity and long implementation cycles. Despite the strategic importance of these projects, the sector continues to face persistent challenges related to time overruns, cost escalations, quality deviations, safety concerns and increasing sustainability pressures, indicating deficiencies in project delivery performance. The Indian steel industry's current project management practices are frequently disjointed, experience-based and inadequately supported by performance frameworks that have been empirically validated These frameworks capture the intricate relationships between governance mechanisms, managerial competencies, risk management techniques, resource planning, technology adoption and stakeholder *engagement*. Although previous research has looked at the various aspects that contribute to project success, there aren't many integrated, theory-driven models that explain how these factors work together to affect project delivery results in the steel industry. The goal of this study is to identify and experimentally validate the key factors that influence project delivery performance and the causal links between them in Indian steel Industries. The study aims to create and validate a thorough Project Delivery Performance framework using a Structural Equation Modelling (SEM) approach. This framework will quantify the direct and indirect effects among important constructs and offer practical insights for improving project execution effectiveness. By providing a methodical, data-driven foundation for enhancing time, cost, quality, safety and sustainability performance in steel industry projects throughout India, the suggested framework seeks to close the gap between project management theory and reality.

By examining the intricate connections between organisational, managerial, technological and stakeholder-related aspects, the current study aims to methodically investigate the factors that influence project delivery success in the Indian steel industry. The study intends to create and validate an integrated framework that explains how these factors jointly influence project delivery outcomes, leading to the following research topics, using a Structural Equation Modelling (SEM) technique.

RQ1: What are the key organizational, managerial, technological and relational factors that significantly influence Project Delivery Performance in the Indian steel sector?

RQ2: How can an empirically validated, SEM-based Project Delivery Performance framework are developed for the Indian steel sector?

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The study's research objectives are formulated as:

- **To identify** the key factors that significantly influences Project Delivery Performance in the Indian steel sector.
- To develop and validate an SEM-based framework for Project Delivery Performance in Indian steel companies by examining the direct and indirect effects of organizational factors.
- **To provide** managerial insights and practical recommendations for improving project delivery effectiveness in Indian steel companies based on the validated framework.

The current study's remaining portions are organised as follows. With a focus on key factors that significantly influences Project Delivery Performance in the steel industry, Section 2 examines pertinent research on project management and project delivery performance. The research design, data collection methods, build measurement and the use of structural equation modelling (SEM) are all covered in Section 3. The data analysis and empirical findings from the measurement and structural models are presented in Section 4. Key theoretical contributions and management implications for the Indian steel industry are highlighted in Section 5, which also discusses the findings in light of previous research and theories.

1. Literature Review

1.1 Project Delivery Performance

In the literature on project management, Project Delivery Performance (PDP) has been extensively studied as a multifaceted concept that includes stakeholder satisfaction, scope achievement, cost, time and quality. Aaron J. Shenhar's early research focused on strategic fit, business impact and long-term organisational advantages, going beyond the conventional "Iron triangle" in its conceptualisation of project performance(Ziebell et al., 2024). Later studies, such as the Project Management Institute's frameworks, emphasised the importance of leadership, governance and standardised procedures in attaining better delivery results(Jahandideh, 2024).

Project Delivery Performance (PDP) refers to how well a Project accomplishes its intended goals in a number of crucial areas. While cost performance shows adherence to allocated budgets and efficient cost control methods, time performance shows the capacity to finish projects within planned timeline, minimising delays and interruptions(Reza & Banadkouki, 2024). According to J. Rodney Turner (2014), quality performance denotes adherence to technical requirements, norms and stakeholder expectations, guaranteeing long-term dependability and suitability for purpose. The project's ability to prevent mishaps, injuries and health risks is measured by its safety performance, which is especially important in heavy industries like Steel Plants. Furthermore, in order to align project outcomes with more general organisational and societal goals, sustainability performance entails integrating social considerations, efficient resource utilisation and environmental responsibility into project execution(Cregan et al., 2024). When taken as a whole, these dimensions encapsulate the strategic and all-encompassing meaning of Project Delivery Performance that goes beyond the conventional iron triangle.

Project Management Capability and Organisational Agility are important mediating elements between Organisational, Managerial and Technological factors that affect Project Delivery Performance (PDP) in capital-intensive and complex sectors like Steel(Thor et al.,). Project governance enhances control over time, cost and quality results by providing the formal methods, accountability structures and decision-making frameworks that match projects with strategic objectives(Shen & Stewart, 2024). Effective project team planning, coordination and motivation are made possible by leadership and managerial competence, which enhances an organization's capacity to handle unforeseen circumstances and performance demands(Zheng & Zwikael, 2024).

While Resource Planning and Allocation guarantees the best possible use of material, human and financial resources throughout project phases, Risk Management Practices facilitate the proactive identification, evaluation and mitigation of project risks, minimising disruptions and enhancing delivery reliability(Kumar & Bhattacharjee, 2014). Additionally, digital tools and technology, such analytics, automation and project management information systems, improve visibility, integration and decision-making speed, which promotes organisational agility(Bhattacharjee et al., 2016). Furthermore, Stakeholder engagement promotes trust, expectation alignment and information flow between internal and external stakeholders, which indirectly enhances PDP by enhancing responsiveness and coordination(Park et al., 2018). When combined, these separate factors have a direct and indirect impact on PDP through improved organisational agility and project management skills.

2.2 Research Gaps

A survey of the literature indicates a number of important research gaps in the field of Project Delivery Performance (PDP), especially when it comes to capital-intensive industries like the steel sector in India. The majority of previous studies use fragmented or linear analytical methodologies and concentrate on individual elements rather than integrated causal links, despite the fact that they have thoroughly analysed traditional project success criteria, primarily time, cost and quality(Chaturvedi Sharma & Goel, 2019; Cregan et al., 2024). Furthermore, within a single Structural Equation Modelling (SEM) paradigm, very little empirical research has concurrently studied stakeholder communication,

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governance, leadership, risk management, resource allocation and technology adoption, particularly with mediating mechanisms.

Despite their increasing importance in handling complexity, ambiguity and dynamic project settings, the mediating functions of organisational agility and project management capability are still little understood(Omar et al., 2024). Furthermore, there is a lack of sector-specific data from Indian steel businesses, which puts theory and practice out of context. In order to fill these gaps and create a thorough and contextually grounded PDP framework, the current study pulls and integrates important organisational, managerial, technological and relational elements from the literature for additional empirical research.

2. Research Methodology

3.1 Research Model

The current study identifies a number of crucial variables depicted in Fig.1, for additional empirical research based on a thorough analysis of earlier research on project management and performance. Because it ensures accountability, strategic alignment and control mechanisms throughout project life cycles, project governance is taken into consideration(Capo & Capo, 2011; Han et al., 2018; Rainbolt et al., 2019). Because of their impact on decision-making, team coordination and the successful completion of challenging projects, managerial competence and leadership are included(Ardelet et al., 2015; Zhao et al., 2022). Key operational factors that improve project predictability, efficiency and resilience against uncertainties are risk management practices and resource planning and allocation(Sukolkit et al., 2024).

The inclusion of **Technology and Digital Tools** reflects the growing importance of digitalization, project information systems and data-driven decision-making in improving project visibility and responsiveness(Omar et al., 2024; Godovykh & Ridderstaat, 2020). **Stakeholder** engagement. is incorporated as a relational variable that facilitates coordination, trust and alignment of stakeholder expectations, which are critical for project success(Sahoo et al., 2022; Aramali et al., 2024). Further, **Project Management Capability** and **Organizational Agility** are taken as mediating variables, as they translate these structural and managerial inputs into superior **Project Delivery Performance** by enabling adaptability, learning and effective execution in dynamic project environments. The increased significance of digitalisation, project information systems and data-driven decision-making in enhancing project visibility and responsiveness is reflected in the incorporation of technology and digital tools(Shen & Stewart, 2024; Thor et al., 2024). (Ziebell et al., ; Lane et al., n.d.) stakeholder communication is included as a relational variable that promotes coordination, trust and alignment of stakeholder expectations—all of which are essential for project success. Furthermore, by facilitating flexibility, learning and efficient execution in dynamic project contexts, organisational agility and project management capability are viewed as mediating variables that convert these managerial and structural inputs into superior project delivery performance.

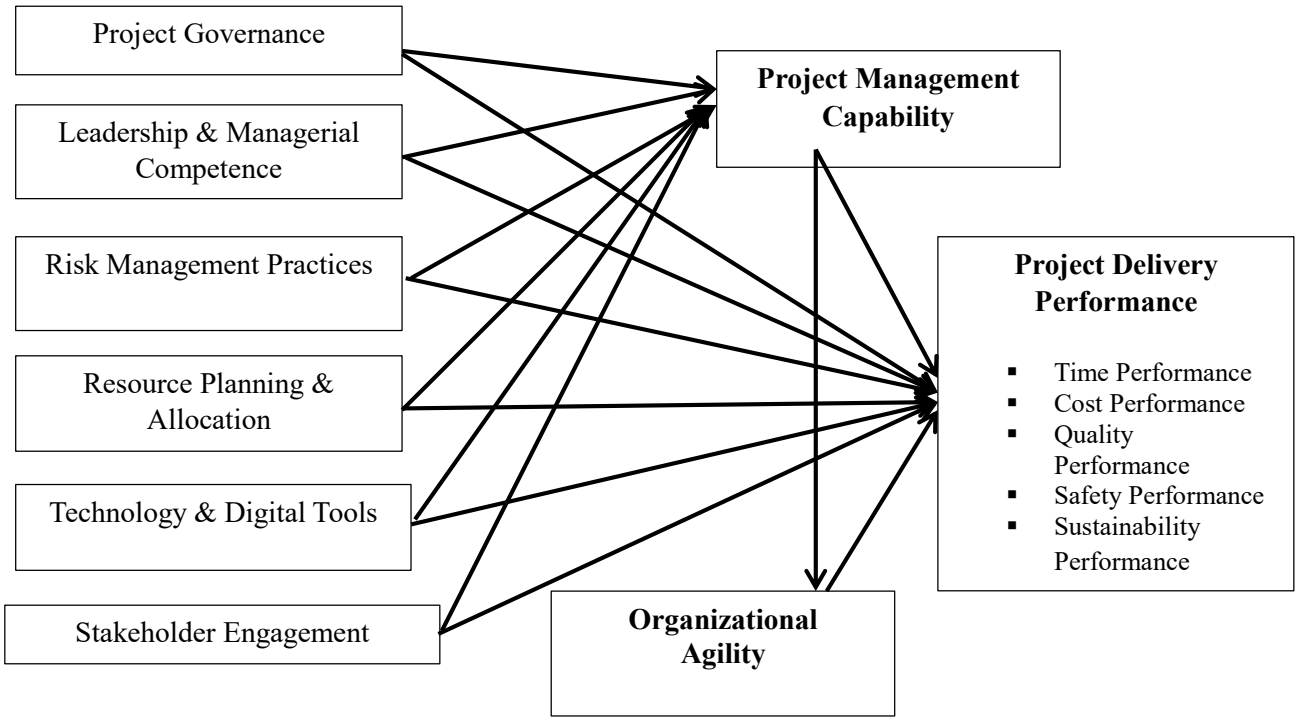

Fig. 1 Research Model *(Source: Author's Own Work)*

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3.2 Research Hypothesis

A. Direct Effects: Exogenous Constructs → Project Management Capability

H_1: Project Governance, Leadership & Managerial Competence, Risk Management Practices, Resource Planning & Allocation, Technology & Digital Tools & Stakeholder Communication & Coordination has a significant positive influence on Project Management Capability.

B. Direct Effects: Exogenous Constructs → Project Delivery Performance

H_2: Project Governance, Leadership & Managerial Competence, Risk Management Practices, Resource Planning & Allocation, Technology & Digital Tools & Stakeholder Communication & Coordination has a significant positive influence on Project Delivery Performance.

C. Mediator Relationships

H_3: Project Management Capability has a significant positive influence on Organizational Agility.
H_4: Project Management Capability has a significant positive influence on Project Delivery Performance.
H_5: Organizational Agility has a significant positive influence on Project Delivery Performance.

D. Mediation Hypotheses

H_6: Project Management Capability mediates the relationship between Project Governance and Project Delivery Performance.
H_7: Project Management Capability mediates the relationship between Leadership and Managerial Competence and Project Delivery Performance.
H_8: Project Management Capability mediates the relationship between Risk Management Practices and Project Delivery Performance.
H_9: Project Management Capability mediates the relationship between Resource Planning and Allocation and Project Delivery Performance.
H_{10}: Organizational Agility mediates the relationship between Project Management Capability and Project Delivery Performance.

3.3 Research Design

The whole research design used in the research is shown in Figure 2, which also shows a methodical and sequential approach to creating and approving a Project Delivery Performance framework for the Indian steel industry. After identifying the research topic and highlighting the need to improve project delivery performance, a thorough analysis of project management and performance-related literature is conducted. Key constructs consisting of exogenous factors, mediators and the endogenous variable are then developed using a quantitative, explanatory, cross-sectional survey methodology. These structures serve as the basis for the development of hypotheses and the design of a structured questionnaire with a five-point Likert scale. Expert evaluation ensures the content validity of the questionnaire. Stratified Random Sampling strategies are used in the study to gather data from project experts. Cronbach's alpha, composite reliability, AVE and the Fornell-Larcker criterion are then used to conduct thorough reliability and validity testing. Confirmatory factor analysis and structural equation modelling are the last methods used to analyse the data.
G*Power software has used to calculate the sample size for this investigation in order to guarantee sufficient statistical power for the analysis of structural equation modelling. According to recognised SEM rules, the minimum required sample size exceeded 300 respondents based on a medium effect size ($f^2 = 0.15$), a significance level of 0.05 and a desired statistical power of 0.80(Bao et al., 2024). Furthermore, sample sizes between 300 and 400 respondents have been effectively used for robust model estimates and validation in earlier empirical studies in the project management, construction and infrastructure sectors (Li & Cao, 2024) As a result, 330 legitimate responses were gathered from India's steel companies, both public and private. In order to ensure thorough representation of important project stakeholders and improve the validity and generalisability of the study findings, the respondents included professionals who were directly involved in project execution, such as project managers, engineers, planning and control executives, operations managers and contract/procurement officers.

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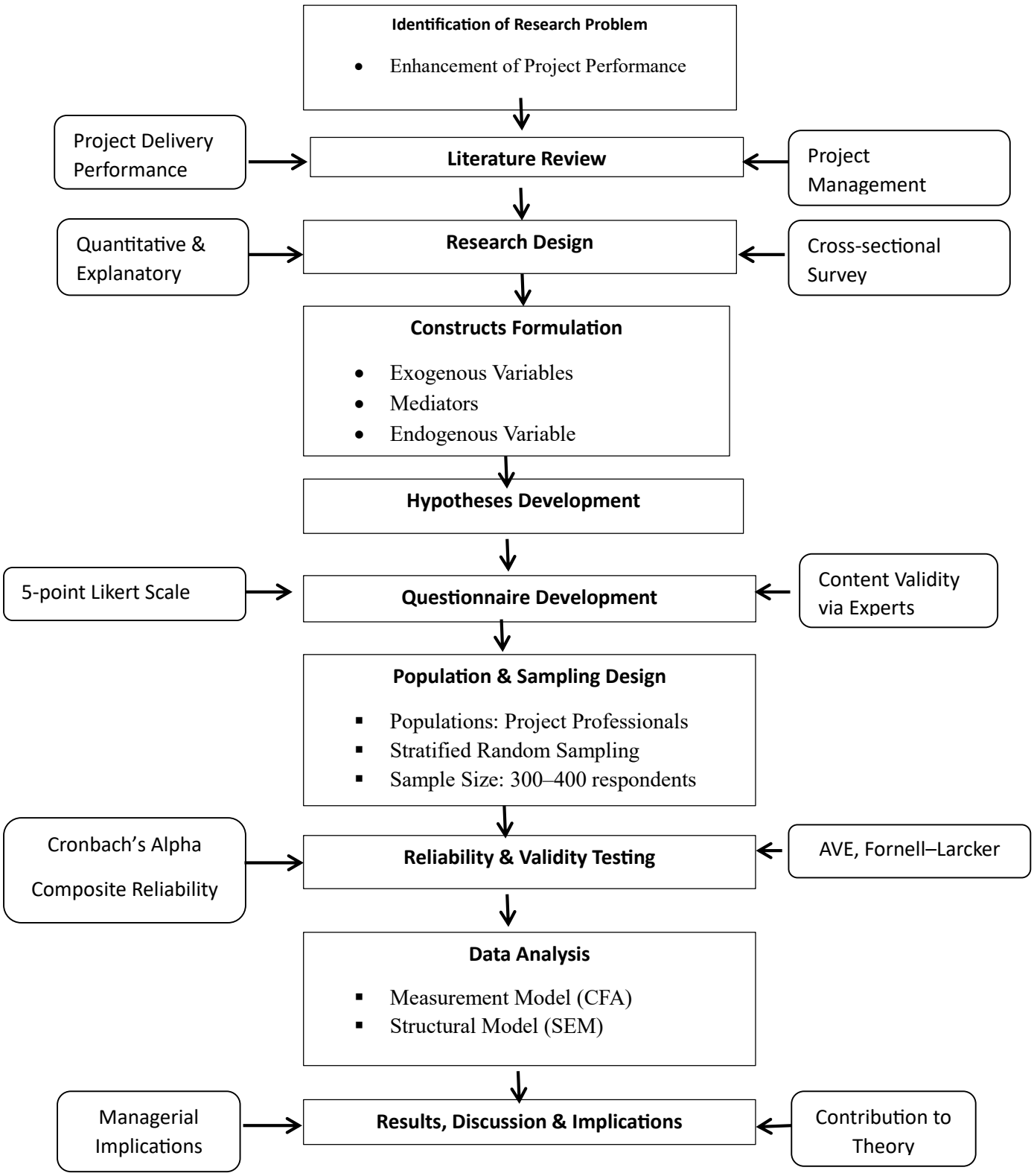

Fig. 2 Research Design *Source: Authors own Work*

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Table

Elements	Items	Frequency	%
Designation	Project Manager	59	17.88
	Engineer	113	34.24
	Planning/Control Executive	59	17.88
	Operations Manager	40	12.12
	Vendors	33	10.00
	Contractor	12	3.64
	Consultant	8	2.42
	Foreign Technology Experts	6	1.82
Organization	Public Sector	129	39.1
	Private Sector	201	60.9
Years of Experience	Less than 5 Years	59	17.9
	5-10	146	44.2
	10-15	67	20.3
	15-20	32	9.7
	Above 20 Years	26	7.9
Nature of Project Involved	Expansion	66	20.0
	Modernization	131	39.7
	Greenfield	52	15.8
	Brownfield	47	14.2
	Others	34	10.3
Project Size	Small < Rs 59 Cr	72	21.82
	Medium Rs 50 – 100 Cr	112	33.94
	Large Rs 100 – 500 Cr	82	24.85
	Mega Rs 500Cr	64	19.39

1:Demographic Details

Table 2: Construct Reliability

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Leadership & Managerial Competence	0.747	0.629	0.295	0.421
Organizational Agility	0.886	0.542	0.374	0.361
Project Governance	0.883	0.297	0.497	0.294
Project Management Capability	0.749	0.537	0.62	0.383
Resource Planning & Allocation	0.733	0.493	0.003	0.333
Risk Management Practices	0.742	0.455	0.015	0.327
Stakeholder Engagement & Coordination	0.765	0.34	0.002	0.302
Technology & Digital Tools	0.864	0.435	0.249	0.351

3.4 Construct Reliability

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The study's latent constructs' reliability and convergent validity results are shown in Table 2. All constructs have Cronbach's alpha values between 0.733 and 0.886, which suggests that the measurement items accurately reflect their respective constructs and indicates an acceptable to high level of internal consistency (Hair et al., 2019). Since composite reliability is thought to be more suitable than Cronbach's alpha for latent variable models, composite reliability measures (ρa and ρc) are given to further evaluate construct dependability in the context of SEM. The reliability estimates show consistency in item assessment overall, despite differences between conceptions. By illustrating how well models account for variance in their indicators, the Average Variance Extracted (AVE) values shed light on convergent validity. Even if certain AVE values are below the traditional cutoff of 0.50, these results are acceptable in applied and exploratory research settings as long as they have a solid theoretical foundation and sufficient composite reliability (Fornell & Larcker, 1981; Hair et al., 2019). Overall, the findings show that the constructs are adequate for further structural model analysis and have a respectable level of reliability.

Table 3: Discriminant Validity- Fornell Larcker Criterion

	Leadership & Managerial Competence	Organizational Agility	Project Governance	Project Management Capability	Resource Planning & Allocation	Risk Management Practices	Stakeholder Engagement & Coordination	Technology & Digital Tools
Leadership & Managerial Competence	0.649							
Organizational Agility	0.202	0.601						
Project Governance	0.492	0.02	0.542					
Project Management Capability	0.194	0.215	0.36	0.618				
Resource Planning & Allocation	0.22	0.097	0.243	0.492	0.577			
Risk Management Practices	0.172	0.282	0.428	0.148	0.076	0.571		
Stakeholder Engagement & Coordination	0.487	0.223	0.297	0.005	0.154	0.011	0.549	
Technology & Digital Tools	0.007	0.361	0.121	0.331	0.142	0.064	0.115	0.593

3.5 Construct Validity- Fornell Larcker Criterion

The findings of the discriminant validity evaluation utilising the Fornell-Larcker criterion are shown in Table 2. For every construct, the square roots of the Average Variance Extracted (AVE), displayed along the diagonal, are greater than the corresponding inter-construct correlation values in the associated rows and columns. This suggests that there is sufficient discriminant validity in the model since each concept shares more variance with its own indicators than with other constructs. Further evidence that these variables reflect fundamentally different aspects of project management methods comes from the comparatively low to moderate correlations among categories like Leadership and Managerial Competence, Organisational Agility, Project Governance and Technology and Digital Tools. The findings support the uniqueness of each construct and provide justification for its inclusion in the structural model for hypothesis testing by showing that the measurement model satisfies the Fornell–Larcker criterion.

3. Data Analysis and Results

3.1 Descriptive Analysis

The descriptive statistics of the main observed variables pertaining to project delivery performance and the factors that influence it are shown in Table 4. The majority of the constructs have moderate to relatively high mean values, with the highest mean scores indicating greater agreement among respondents for Leadership and Managerial Competence (LMC1), Project Governance (PG1), Stakeholder Engagement and Coordination (SCC1) and Sustainability Performance. Project Management Capability (PMC1), Risk Management Practices (RMP1) and Technology and Digital Tools (TDT1), on the other hand, have lower mean values, indicating room for improvement in these areas within steel sector projects. The values of excess kurtosis and skewness are mostly within acceptable bounds (±2), suggesting that the data is roughly normal. Nonetheless, the findings of the Cramér-von Mises test show statistically

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significant departures from strict normality for a number of variables, supporting the application of robust SEM estimation methods.

Table 4 Descriptive Analysis

	Mean	Median	Standard deviation	Excess kurtosis	Skewness	Cramér-von Mises test statistic	Cramér-von Mises p value
Cost Performance	2.9	3	1.33	-1.046	0.347	0.343	0
LMC1	3.94	4	1.207	0.787	-1.289	0.82	0
OA1	2.98	3	1.334	-1.313	-0.014	0.376	0
PG1	3.94	4	1.207	0.787	-1.289	0.82	0
PMC1	2.48	2	1.237	-0.465	0.701	0.471	0
Quality Performance	3	3	1.249	-1.063	0.064	0.276	0.001
RMP1	2.56	2	1.203	-0.454	0.637	0.436	0
RPA1	3.04	3	1.326	-1.276	-0.023	0.341	0
SCC1	3.96	4	1.131	0.425	-1.118	0.704	0
Safety Performance	2.68	2	1.318	-0.712	0.676	0.554	0
Sustainability Performance	3.8	4	1.296	-0.066	-1.034	0.701	0
TDT1	2.58	2	1.25	-0.575	0.667	0.507	0
Time Performance	3.08	3	1.398	-1.4	0.034	0.365	0

4.2 Collinearity Statistics

The variance inflation factor (VIF) values for each of the endogenous constructs and observable indicators that were part of the model to evaluate possible multicollinearity problems are shown in Table 5. The findings demonstrate that there are no multicollinearity issues because the VIF values for the original sample fall between 1.003 and 1.369 and the sample mean values are still much below the generally accepted criterion of 3.3 (and the cautious threshold of 5.0). The consistency of these estimates over bootstrap samples is further shown by the lower and upper bounds (2.5% and 97.5%). The robustness and dependability of later SEM route estimations are supported by the collinearity diagnostics, which show that the measurement and structural models are free from multicollinearity bias.

Table 5 Collinearity Statistics (VIF)

	Original sample (O)	Sample mean (M)	2.50%	97.50%
Cost Performance	1.161	1.283	1.057	1.719
LMC1	1.359	1.461	1.114	2.053
LMC2	1.019	1.091	1.005	1.311
LMC3	1.369	1.473	1.123	2.056
LMC4	1.108	1.162	1.042	1.366
OA1	1.226	1.324	1.06	1.803
OA2	1.013	1.08	1.006	1.253
OA3	1.024	1.092	1.006	1.288
OA4	1.213	1.301	1.051	1.755
PG1	1.041	1.126	1.011	1.402
PG2	1.017	1.076	1.006	1.252
PG3	1.018	1.091	1.006	1.325
PG4	1.046	1.131	1.011	1.405
PMC1	1.033	1.11	1.008	1.366
PMC2	1.232	1.346	1.105	1.769
PMC3	1.217	1.305	1.049	1.791
PMC4	1.056	1.137	1.011	1.421
Quality Performance	1.136	1.239	1.046	1.61
RMP1	1.018	1.093	1.007	1.304
RMP2	1.019	1.093	1.006	1.317
RMP3	1.113	1.186	1.029	1.485
RMP4	1.111	1.178	1.031	1.453
RPA1	1.154	1.244	1.034	1.655
RPA2	1.005	1.068	1.003	1.237

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RPA3	1.147	1.239	1.036	1.639
RPA4	1.035	1.088	1.007	1.268
SCC1	1.069	1.128	1.016	1.348
SCC2	1.067	1.122	1.014	1.331
SCC3	1.036	1.098	1.008	1.3
SCC4	1.003	1.065	1.004	1.219
Safety Performance	1.161	1.274	1.065	1.674
Sustainability Performance	1.048	1.147	1.018	1.445
TDT1	1.139	1.22	1.026	1.598
TDT2	1.111	1.204	1.018	1.615
TDT3	1.063	1.141	1.013	1.422
TDT4	1.186	1.274	1.051	1.71
Time Performance	1.3	1.44	1.124	1.997

4.3 Measurement Model Evaluation

The suggested model for Project Delivery Performance (PDP) in the Indian steel industry has a strong explanatory power, according to the SEM path results shown in Figure X. The model demonstrates that the chosen organisational, managerial, technological and relational elements jointly exert a large influence on project outcomes by explaining a significant percentage of the variance in PDP (R^2 = 0.625). Project Governance, Leadership and Managerial Competence, Risk Management Practices, Resource Planning and Allocation, Technology and Digital Tools and Stakeholder Communication and Coordination all have a significant impact on PDP, with Project Management Capability (PMC) emerging as a key mediating construct (R^2 = 0.514). Furthermore, the significance of flexibility and responsiveness in intricate steel projects is reflected in the complementary mediating effect of organisational agility (R2 = 0.619). Their crucial significance in improving time, cost, quality, safety and sustainability performance is confirmed by the positive and significant direct path coefficients from PMC to PDP and from Organisational Agility to PDP.

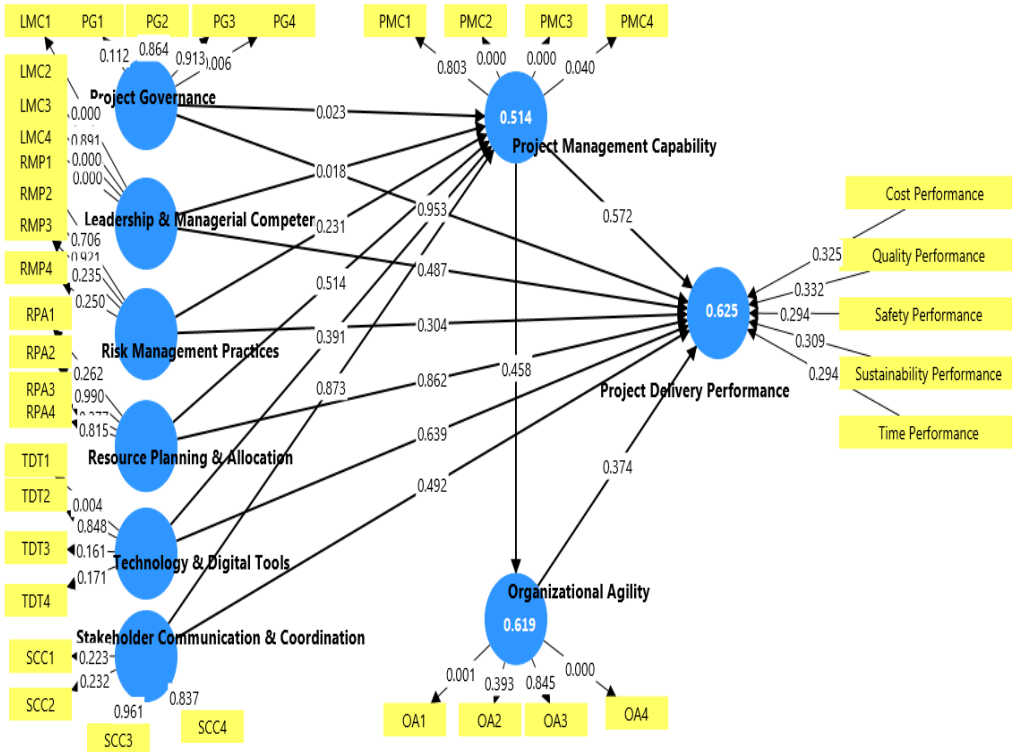

Fig.3 PLS SEM Structural Model

The outcomes of the hypothesis testing for the suggested structural model are collected in Table 6. The results show conflicting evidence in favour of the proposed links. While its impact on Organisational Agility (H3b) is not substantiated, Leadership and Managerial Competence demonstrates a strong direct influence on Project Delivery

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Performance and Project Management Capability, verifying H2b and H1b. Project governance has a major impact on organisational agility and project management capability (H1a and H3a), but it has no direct effect on project delivery performance (H2a), indicating a role that is indirect rather than direct. Project Delivery Performance is significantly improved by Organisational Agility (H5), indicating its mediating significance. On the other hand, there is no evidence to support the direct effects of project management capability on organisational agility and project delivery performance (H3 and H4). Resource allocation and planning have a major impact on organisational agility (H3d) among operational elements, but they have no direct effect on project delivery performance or project management capability (H2d and H1d). Project Delivery Performance (H2c) is greatly impacted by risk management practices, although Organisational Agility and Project Management Capability (H3c and H1c) are not much affected. Overall, the findings demonstrate how organisational agility plays a crucial mediating role and how governance, leadership and risk management have specific direct implications on project delivery performance in the Indian steel industry.

Table 6 Hypothesis Testing

Hypothesis	Structural Path	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Conclusion
H3b	Leadership & Managerial Competence -> Organizational Agility	0.088	0.033	0.092	0.96	0.338	Negated
H2b	Leadership & Managerial Competence -> Project Delivery Performance	0.137	0.002	0.041	3.34	0.069	Validated
H1b	Leadership & Managerial Competence -> Project Management Capability	-0.409	-0.255	0.173	-2.4	0.018	Validated
H5	Organizational Agility -> Project Delivery Performance	0.253	-0.022	0.084	3.01	0.024	Validated
H3a	Project Governance -> Organizational Agility	0.132	0.067	0.036	3.67	0.033	Validated
H2a	Project Governance -> Project Delivery Performance	-0.081	-0.002	0.199	-0.4	0.682	Negated
H1a	Project Governance -> Project Management Capability	-0.612	-0.354	0.268	-2.3	0.023	Validated
H3	Project Management Capability -> Organizational Agility	-0.215	-0.189	0.29	-0.7	0.458	Negated
H4	Project Management Capability -> Project Delivery Performance	0.156	0.013	0.348	0.45	0.653	Negated
H3d	Resource Planning & Allocation -> Organizational Agility	-0.044	0.035	0.007	-6.3	0.049	Validated
H2d	Resource Planning & Allocation -> Project Delivery Performance	0.067	0.001	0.025	2.68	0.765	Negated
H1d	Resource Planning & Allocation -> Project Management Capability	0.205	-0.062	0.314	0.65	0.514	Negated
H3c	Risk Management Practices -> Organizational Agility	0.067	0.014	0.091	0.74	0.46	Negated
H2c	Risk Management Practices -> Project Delivery Performance	-0.477	0.019	0.022	-22	0.038	Validated
H1c	Risk Management Practices -> Project Management Capability	-0.312	-0.019	0.26	-1.2	0.231	Negated

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4. Discussion and Findings

The results of this study confirm a SEM-based performance enhancement framework and offer solid empirical data on the factors influencing Project Delivery Performance (PDP) in the Indian steel industry, both of which are in line with the stated research objectives. The findings show that the suggested model has a high degree of explanatory power and can explain a significant amount of the variation in PDP ($R2 = 0.625$), which satisfies the goal of identifying important influencing elements. Project governance, leadership and managerial competency, risk management practices, resource planning and allocation, technology and digital tools and stakeholder Engagement and coordination are some of the key antecedents that influence project outcomes. These factors are influenced by organisational, managerial, technological and relational factors. Crucially, the results show that these elements have a significant impact on PDP through Organisational Agility and Project Management Capability, underscoring their crucial mediating roles in intricate steel projects. Effective project delivery is accomplished through capability-building and adaptive organisational mechanisms rather than direct control alone, as evidenced by the selective direct effects of leadership and governance on PDP, despite the fact that these factors greatly improve project management capability and agility.

The noteworthy benefits of Organisational Agility on PDP highlight how crucial adaptability and responsiveness are to the management of large-scale, technologically complex steel projects. Additionally, PDP is strongly impacted by risk management practices, highlighting the vital role that proactive risk identification and mitigation play in meeting time, cost, quality, safety and sustainability goals. By validating a context-specific SEM-based framework, the findings collectively fulfil the second objective. The third research objective, which focuses on providing managerial insights and practical recommendations for improving project delivery effectiveness in Indian steel companies, is addressed in detail in the **recommendations** section based on the findings of the validated SEM framework.

4.1 Thoretical Implications

The current work advances a structured, SEM-based understanding of Project Delivery Performance (PDP) in the context of the Indian steel industry, making numerous significant theoretical additions to the literature on project management and operations management. First, by empirically validating PDP as a multidimensional construct that encompasses time, cost, quality, safety and sustainability performance, the research goes beyond the conventional "iron triangle" perspective and advances classical project success theories(Shen & Stewart, 2024; Thor et al., 2024). Second, the study addresses calls in the literature for more comprehensive and system-based project performance frameworks by combining Project Governance, Leadership and Managerial Competence, Risk Management Practices, Resource Planning and Allocation, Technology and Digital Tools and Stakeholder Engagement into a single structural model(Cregan et al., 2024; Omar et al., 2024; Sukolkit et al., 2024). Third, the results offer compelling theoretical evidence for the mediating function of organisational agility and project management capability, supporting dynamic capability theory, which holds that organisational resources largely affect performance outcomes through adaptive mechanisms and capability development(Jahandideh, 2024; Ziebell et al., 2024). According to Rigby, Sutherland and Takeuchi (2016), the importance of organisational agility is also consistent with current project management literature that emphasises adaptability and responsiveness in challenging and unpredictable project environments.

Lastly, by providing industry-specific empirical data from steel manufacturing projects, the validated framework advances contextual project management theory and enhances current international standards and conceptual models put forth by organisations like the Project Management Institute. Overall, the work provides a strengthened theoretical lens for future project management research by connecting government and managerial inputs to project results through processes based on capability and agility.

4.2 Practical Implications

The study's findings offer practitioners in the Indian steel sector several practical lessons. The verified SEM-based framework emphasises that enhancing Project Management Capability and promoting Organisational Agility are two more ways to improve Project Delivery Performance (PDP) than only exercising direct management control. This suggests that steel businesses must make investments in competency-based project management training, leadership development and strong governance frameworks that facilitate prompt decision-making and accountability. The importance of methodical risk identification, assessment and mitigation throughout all project phases is highlighted by the substantial impact that risk management practices have on PDP. Large-scale steel projects can also benefit from improved coordination and responsiveness through improved resource planning and allocation, the use of cutting-edge digital and project management tools and improved stakeholder Engagement. All of these ramifications point to the need for managers to concentrate on developing flexible project systems and capabilities in order to enhance overall project delivery effectiveness in a highly complex and capital-intensive business by improving time, cost, quality, safety and sustainability outcomes.

4.3 Recommendations

The research suggests that Indian steel businesses implement an integrated approach to project management that places a high priority on organisational agility and competence development, based on the verified SEM framework. To improve alignment between strategic objectives and project execution, senior management can fortify project governance systems by precisely defining roles, accountability structures and decision-making authority. Planning, coordination and control across project phases should be enhanced by institutionalising targeted leadership and managerial competence development programs. In order to proactively manage uncertainties, the findings further recommend formalising risk management methods and incorporating them into standard project procedures. In order to promote transparency, collaboration and real-time monitoring, organisations should also invest in digital project management tools and upgrade stakeholder engagement systems. Steel firms can convert organisational and managerial inputs into better project delivery results in terms of time, cost, quality, safety and sustainability by putting these recommendations into practice.

5. Conclusions, Limitations and Future Research Scope

The study comes to the conclusion that organisational, managerial and operational factors all have a major impact on project delivery performance in the Indian steel industry, with organisational agility and project management capability acting as important moderators. A thorough and context-specific explanation of how governance, leadership, risk management, resource planning, technology adoption and stakeholder engagement all contribute to better project results is given by the verified SEM-based framework. The study's cross-sectional methodology, dependence on perceptual survey data and steel industry focus are some of its limitations, though and these may restrict the capacity to draw conclusions about causality and generalisability. By using longitudinal designs, adding objective project success measurements and expanding the framework to other capital-intensive sectors including construction, power and infrastructure, future research may be able to overcome these constraints.

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