

Synchronising People, Processes and Business Environment for Project Management Effectiveness: A Mixed-Methods Study of the Indian Steel Industry

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Abstract: Executing projects in India's integrated steel plants depends on properly synchronizing people, processes, and the business environment. However, empirical evidence on the relationships between these three dimensions and project management effectiveness (PME) remains limited. This paper tests a model in which People Synchronisation (PS), Process Synchronisation (PR), and Business Environment (BE) are hypothesized to positively affect PME, using a quantitative approach followed by a qualitative documentary analysis of industry literature. The study administered a 16-item, five-point Likert-scale questionnaire to 160 individuals from the project, operations, quality, procurement, human resource management, and technical departments of 21 Indian integrated steel and long-products companies. The data were analyzed using descriptive statistics, reliability analysis, the Kaiser-Meyer-Olkin (KMO) measure, Bartlett's test of sphericity, Exploratory Factor Analysis (EFA), Pearson correlation, Confirmatory Factor Analysis (CFA), Structural Equation Modeling (SEM), and multiple regression. All computations have been made through Python with SPSS output conventions. The Cronbach's alpha values for all four constructs were well below the commonly used threshold of 0.70 (alpha = 0.12–0.22), and the KMO value was 0.491. Bartlett's test of sphericity was non-significant ($\chi^2 = 127.31$, $df = 120$, $p = 0.307$), indicating that the correlation matrix does not provide sufficient evidence of relationships among the items for factor analysis. The CFA four-factor model produced an inadmissible (Heywood) solution, and all structural paths from PS, PR, and BE to PME were non-significant. In the composite-score multiple regression, the model explained 2.7% of the variance in PME ($R^2 = 0.027$, $F(3,156) = 1.44$, $p = 0.233$). Because the instrument lacked latent structure, none of the hypothesized relationships were validated. The findings are discussed in detail, along with possible reasons related to instrument- and sample-related issues and methodological problems, including common method variance and single-source bias.

Keywords: Project management effectiveness, people synchronisation, process synchronisation, business environment, structural equation modelling, steel industry, reliability analysis.

1 INTRODUCTION

The Indian steel sector is undergoing one of the largest industrial build-outs in its history, in both size and ambition. Installed capacity has crossed 200 MTPA and is expected to increase further to 300 MTPA by 2030 [1]. As investment interest has grown, industry observers believe the key obstacle to realizing this capacity is not a lack of capital, but the efficiency with which sanctioned projects can be executed and brought to completion on time, on budget, and to specifications. Existing modes of delivery are increasingly perceived to fall short of the level of efficiency required for the current batch of projects [1].

In brownfield-dominated environments such as steel plants, where capital expenditure is intensive, PME depends not only on technical planning and management skills but also on organizational, procedural, and environmental factors. Early Critical Success Factor (CSF) studies of construction and engineering projects categorized determinants of project success as project-related, procedural, human, and environmental factors, indicating that these determinants can operate in combination [2],[3]. Similarly, Pinto and Slevin's influential ten-factor framework identified factors associated with successful project implementation, including mission, top-management support, scheduling, personnel, communication, and monitoring [4].

Recent research on CSFs in developing-country construction projects also highlights sustainability, stakeholder involvement, and external conditions as relevant dimensions of project management practice [5]. In Indian steel projects, the applied literature notes common execution issues, including fragmented project documentation, poor cross-functional coordination among engineering, production, and construction teams, and vulnerability to regulatory and input-price instability that affects project schedules [6].

It inspires the three-dimensional conceptual framework in which

- i. PS represents role clarity, cross-functional coordination, workforce competence, and communication with management;
- ii. PR represents following planning, scheduling, and monitoring procedures, proper documentation practices, and cross-departmental integration of processes; and
- iii. BE includes the factors of regulatory environment, market and input price volatility, organizational flexibility, and supply chain reliability.

The three variables are hypothesised to jointly affect PME, defined as schedule adherence, budget adherence, quality conformance, and satisfaction with project delivery. This study makes two contributions. First, it operationalizes and empirically examines the PS-PR-BE-PME model using primary survey data from 160 respondents across project, operations, quality, procurement, human resource management, and technical departments of 21 Indian steel companies. Second, it transparently reports psychometric and structural analyses, including reliability analysis, KMO/Bartlett tests, EFA, CFA, SEM, and regression analysis.

The PS-PR-BE-PME model structure is examined through a sequence of psychometric and structural analyses, including reliability analysis, KMO/Bartlett tests, EFA, CFA, SEM, and regression analysis, rather than being assessed solely through summary statistics. The PS-PR-BE-PME analyses report results as obtained from the data, including non-admissible results, without modifying the statistical outcomes to achieve acceptable model fit [7]. The paper is structured as follows: Section 2 reviews the literature underlying the PS-PR-BE-PME model, Section 3 describes the research methodology, Section 4 presents the quantitative results and documentary analysis, Section 5 discusses the findings and their implications, Section 6 presents the implications, Section 7 lists the limitations, and Section 8 concludes.

2 LITERATURE REVIEW

The research literature on project management effectiveness suggests that effective project implementation depends on a complex interrelationship of human, procedural, and contextual elements, rather than on technical planning ability. In industrial enterprises where the project process is particularly complicated and capital-intensive, these elements interact in ways that depend on how well all functions are coordinated. This section provides an overview of the theoretical and empirical basis for the aforementioned dimensions, including critical success factors, the context of the Indian steel industry, project management effectiveness measurement, and the psychometric and structural requirements of the current research.

2.1. Critical Success Factors and the People-Process-Environment Triad

The systematic analysis of project success determinants was pioneered by Rockart's CSF approach and later applied to the construction and engineering context by Sanvido et al., who developed an Integrated Building Process Model and found a clear association between the successful realization of certain conditions and the success of sixteen projects [3]. Based on this work, the application of CSFs to project management practices has resulted in a consistent convergence on a few major categories of factors, namely project management actions, project procedures, human factors, and environment-related factors, emphasizing the necessity of Synchronisation of all factors to ensure timely completion of the project [2]. This theory forms the theoretical basis of the People-Process-Business Environment Synchronisation framework used in this research.

Pinto and Slevin's ten-factor framework, based on the experience of full-time project managers, remains one of the most referenced operationalizations of project implementation success and explicitly divides people-oriented factors, such as personnel and communication, from process-oriented factors, such as scheduling, monitoring, and technology [4]. Recent research on CSFs in the construction industry in developing countries shows that their relevance and interactions are context-dependent, with sustainability and stakeholder-related factors increasingly becoming as significant as environment-related factors [5].

2.2. Project Management in the Indian Steel Industry Context

Specifically, the literature on the Indian steel industry suggests that steel projects—including greenfield, brownfield, modernization, and debottlenecking projects—face execution challenges that vary with project characteristics, stakeholder requirements, and funding considerations [6]. Similarly, the review of the literature on project management practices in the Indian steel sector carried out by Kumar and Kumar shows that the project delivery process in this industry involves considerable risks related to time and is driven by limitations of capital and coordination difficulties; the type of project (greenfield, modernization, or expansion) significantly determines the management approach that should be applied to its implementation.

More recent analyses describe project-execution challenges in the industry in terms of Synchronisation, as India's simultaneous capacity expansion makes fragmented approaches to project delivery increasingly difficult and highlights the need for design standardization, modularization, and digitalization [1], [6].

2.3. Measurement of Project Management Effectiveness

Project management effectiveness is generally distinguished from project success. Effectiveness refers to the extent to which the management process achieves desired results in terms of time, cost, and quality. In contrast, project success encompasses broader outcomes defined from the stakeholder perspective. A literature review comparing efficiency and effectiveness in project-oriented organizations finds that practitioners often confuse the two. The literature suggests operationalizing effectiveness through schedule compliance, budget compliance, and quality compliance measures, in addition to overall satisfaction with the process; the current scale follows this approach.

2.4. Psychometric and Structural Equation Modelling Standards

Cronbach's alpha has traditionally been used to assess internal consistency reliability, with values above 0.70 commonly adopted as a reference threshold in basic research [8]. However, this threshold should not be treated as universal, particularly because it was originally intended for early exploratory measurement [8]. The KMO measure of sampling adequacy and Bartlett's test of sphericity are commonly used to assess whether a correlation matrix is suitable for factor analysis. The KMO measure evaluates sampling adequacy, whereas Bartlett's test assesses whether the correlation matrix differs significantly from an identity matrix [9], [10]. In the case of confirmatory factor analysis and structural equation modeling, Hu and Bentler's simulation-based two-index approach is commonly used when evaluating model fit, with combinations involving CFI or TLI around 0.95 and RMSEA around 0.06 or SRMR around 0.08 [11]. Finally, because this research uses single-source, self-reported, cross-sectional data, common-method variance is relevant, as it can distort or mask true relationships between the constructs measured in the study [12].

2.5. Research Gap and Hypotheses

Although considerable research exists on CSF and project management effectiveness internationally, and on project implementation in the Indian steel industry, little research has examined the psychometrically tested PS–PR–BE–PME model of project management effectiveness in the Indian steel industry. The present study attempts to address this research gap and tests the following hypotheses:

- H1: PS is positively related to PME.
- H2: PR is positively related to PME.
- H3: BE is positively related to PME.

3 RESEARCH METHODOLOGY

This section discusses the methodology adopted to explore the connection between People Synchronisation, Process Synchronisation, Business Environment, and Project Management Effectiveness in the Indian steel sector. It explains the research design, sample selection process, data collection methods, survey tool, statistical tools used for data analysis, and the study's ethics. The methodology combines quantitative and documentary qualitative elements.

3.1. Research Design

The current research adopts a quantitatively dominant sequential mixed-methods design (QUAN→qual) [13]. The quantitative strand comprises a cross-sectional survey of 160 respondents, followed by a documentary qualitative strand that provides context for interpreting the quantitative findings. The major component is a cross-sectional survey using primary quantitative data (N = 160), which was assessed through a sequence of psychometric and structural analyses, including reliability testing, sampling adequacy assessment, EFA, Pearson correlation, CFA, SEM, and multiple regression with analysis of variance (ANOVA) and independent-samples comparisons. The supplementary component of this research involves qualitative document analysis and content analysis of secondary citable sources on Indian steel project implementation. These citable sources may include practitioner reports and peer-reviewed case studies of Indian steel project implementation. Such documents were used to provide contextual interpretation of the quantitative results, particularly where the statistical findings differed from the hypotheses (Section 5.2). The study used no primary interviews or open-ended survey questions; therefore, the qualitative component is document-based.

3.2. Sample and Data Collection

The researchers designed and administered a questionnaire to employees in the project, operations, quality, procurement, human resource management, and technical departments of 21 Indian integrated steel and long products producers, as described below. These respondents included employees involved in greenfield, brownfield expansion, capacity expansion, modernization, revamp/up-gradation, and debottlenecking projects. In total, 160 valid responses were left after eliminating incomplete questionnaires; for detailed information on the sample, see Section 4.1.

As the respondents were drawn from 21 firms, some responses may reflect the organizational context of the same firm. The analyses were therefore conducted at the respondent level, with this aspect considered when interpreting the findings. Participants held positions such as Assistant General Manager, Quality Control Manager, Plant Head, Project Coordinator, and Senior Project Engineer, and had 3 to 28 years of experience in this area ($M=15.5$, $SD=7.80$).

3.3. Instrument

The questionnaire contained 16 questions answered using a five-point Likert scale (1= Strongly Disagree to 5= Strongly Agree). The questions were grouped under four a priori constructs, each containing four questions: People Synchronisation (PS1-PS4), Process Synchronisation (PR1-PR4), Business Environment (BE1-BE4), and Project Management Effectiveness (PME1-PME4). Scores for each construct were calculated by taking the average of the questions forming the construct.

3.4. Data Analysis Procedure

The statistical analyses were carried out using Python 3.12 with the pandas, pingouin, factor_analyzer, semopy, and statsmodels libraries, following the usual conventions for reporting in SPSS/AMOS studies to facilitate comparison with similar works in the literature. The sequence of analyses consisted of the following steps:

- i. data cleaning and testing for missing values;
- ii. descriptive statistics, skewness and kurtosis, and Shapiro-Wilk normality tests;
- iii. assessing internal-consistency reliability by means of Cronbach's alpha and corrected item-total correlations (the criterion of 0.70 was used [8]);
- iv. assessing sampling adequacy with the help of the KMO index and Bartlett's test of sphericity [9], [10];
- v. EFA with principal-axis extraction and Promax rotation and a priori specification of four factors;
- vi. Pearson correlation between construct scores;
- vii. CFA of the hypothesized four-factor model using maximum likelihood estimation, with the observed distributional characteristics taken into account when interpreting the results;
- viii. estimation of the whole SEM with PME regressed on PS, PR and BE; and
- ix. composite-score multiple linear regression analysis with variance inflation factor and Durbin-Watson statistics in addition to one-way ANOVA and independent-samples t-tests by demographic subgroups.

This set of analyses was performed as a robustness check, given the results from the CFA/SEM analyses (see Section 4.7).

3.5. Ethical Considerations

Participation was voluntary and anonymous. No identifying information was collected, and participants were informed of the research's academic purpose before completing the questionnaire. The names of firms included in Section 4.1 are grouped purely for descriptive profiling.

4 RESULTS

This section presents the empirical results from the quantitative survey and the corresponding documentary analysis. The results are described systematically, starting with demographic and organizational descriptions of the respondents, descriptive statistics and normality tests, internal consistency, sampling adequacy, EFA, correlation analysis, confirmatory factor analysis and structural equation modeling, regression analysis robustness tests, comparison between subgroups, and documentary content analysis. The study paid close attention to psychometric and structural aspects, aiming to assess not only the assumed relationships but also the measurement model's empirical viability. If the findings did not support the model assumptions, the results are stated without distortion.

4.1. Demographic Profile of Respondents

The demographics and organizational background of the respondents provide an empirical basis for understanding the statistical findings that follow. Table 1 shows the sample composition by experience, departmental function, and project type for the 160 respondents who participated in the survey. The respondents belong to 21 firms, including Tata Steel Ltd., JSW Steel Ltd., Jindal Steel & Power (JSPL), SAIL (Rourkela and Bokaro plants), Vedanta-ESL Steel, Shyam Metalics & Energy, Kalyani Steels, and NMDC Steel. Geographically, the plant locations span Jharkhand, Odisha, Chhattisgarh, Karnataka, and Maharashtra. Thus, the sample consists of people working in different organizational and project settings in the steel industry in India.

Table 1. Demographic and organisational profile of respondents (N = 160).

Category	Group	n	%
Experience (years)	≤ 5	22	13.8
	6–10	29	18.1
	11–15	29	18.1
	16–20	27	16.9
	>20	53	33.1
Department	Operations	29	18.1
	Project Management	29	18.1
	Quality Assurance	12	7.5
	Engineering & Projects	9	5.6
	Health, Safety & Environment	9	5.6
	Production	9	5.6
	Supply Chain	9	5.6
	Project Planning & Control	9	5.6
	Electrical & Instrumentation	8	5.0
	Procurement & Contracts	8	5.0
	Mechanical Maintenance	8	5.0
	Human Resources	6	3.8
	Erection & Commissioning	6	3.8
	Civil & Structural	5	3.1
	Finance & Accounts	4	2.5
Project type handled	Revamp / Upgradation	37	23.1
	Greenfield	30	18.8
	Debottlenecking	27	16.9
	Modernisation	26	16.3
	Brownfield Expansion	20	12.5
	Capacity Expansion	20	12.5

As per Table 1, the sample is well represented across experience levels and functional areas. The largest group has more than 20 years of experience (n = 53, 33.1%), followed by those with 6-10 years and 11-15 years of experience (n = 29, 18.1% each). Those with 16-20 years of experience account for 16.9%, while those with up to 5 years account for 13.8% of the sample. By function, Operations and Project Management have the largest share, with 29 respondents each (18.1%), followed by Quality Assurance, with 12 respondents (7.5%). The remaining respondents include those from Engineering and Projects, Health, Safety and Environment, Production, Supply Chain, Project Planning and Control, Electrical and Instrumentation, Procurement and Contracts, Mechanical Maintenance, Human Resources, Erection and Commissioning, Civil and Structural, and Finance and Accounts.

Furthermore, the distribution by project type shows diversity in the steel-project contexts represented in the sample. The largest category in terms of the number of respondents includes Revamp or Upgradation projects (n = 37, 23.1%), followed by Greenfield projects (n = 30, 18.8%), Debottlenecking (n = 27, 16.9%), Modernisation (n = 26, 16.3%), Brownfield Expansion (n = 20, 12.5%) and Capacity Expansion (n = 20, 12.5%). This representation is important because the proposed PS-PR-BE-PME framework will consider various project management conditions across different types of industrial project execution.

The designation profile suggests considerable managerial and technical experience. The most popular designations among respondents include Assistant General Manager (n = 12), Quality Control Manager (n = 12), Plant Head (n = 11), Project Coordinator (n = 11), Senior Project Engineer (n = 9), Safety Officer (n = 9), Production Manager (n = 9), Procurement Manager (n = 9), and Planning Engineer (n = 9). Other respondent designations include project, engineering, operations, maintenance, human resources, and finance. The mean experience is 15.5 years (SD = 7.80, range = 3 to 28 years).

4.2. Descriptive Statistics and Normality

In the second stage of analysis, attention shifted to the central tendency, spread, and distribution of the constructs examined. Table 2 presents descriptive statistics for PS, PR, BE, and PME, while Fig. 1 illustrates the distribution of the constructs' values. This step helps identify the general response pattern before testing reliability and conducting factor analysis.

Table 2. Descriptive statistics of construct scores (N = 160, 5-point Likert scale).

Construct	Items	Mean	SD	Skewness	Kurtosis
PS	PS1–PS4	4.053	0.532	–0.398	–0.119
PR	PR1–PR4	4.025	0.542	–0.375	–0.351
BE	BE1–BE4	3.875	0.561	–0.389	–0.613
PME	PME1–PME4	4.088	0.498	–0.288	0.128

Table 2 shows that respondents rated all four constructs quite favorably, as indicated by the mean scores. To be more specific, mean scores varied from 3.875 in BE to 4.088 in PME. PS scored 4.053, whereas PR scored 4.025. Standard deviations were low, ranging from 0.498 in PME to 0.561 in BE. Skewness and kurtosis were relatively low, ranging from –0.398 to –0.288 for skewness and from –0.613 to 0.128 for kurtosis. However, the Shapiro-Wilk tests were statistically significant for all four construct scores ($p < 0.001$ – 0.0005), indicating departures from univariate normality. Given the bounded nature of the composite scores and the sample size (N = 160), these departures were treated as a boundary condition for the subsequent CFA, SEM, and ordinary least squares (OLS) analyses. In addition to the numerical descriptive statistics above, Fig. 1 shows box plots of the score distributions for the four constructs under discussion.

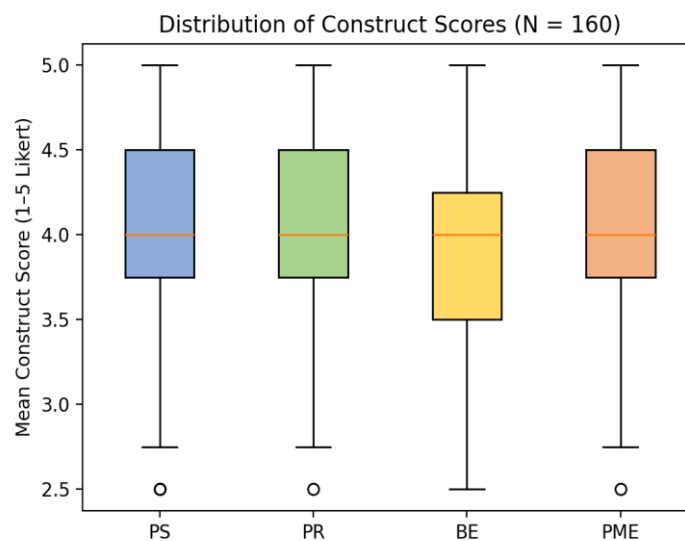


Fig. 1. Distribution of construct scores by Box plot (N = 160).

Together, Table 2 and Fig. 1 show that respondents had favorable perceptions of all four concepts, with PME having the highest mean score and BE the lowest.

4.3. Reliability Analysis (Cronbach's Alpha)

After the descriptive analysis, the internal consistency of items belonging to each construct was assessed using Cronbach's alpha and corrected item-total correlations. Table 3 shows the Cronbach's alpha values, confidence intervals, and corrected item-total correlations for the constructs and the instrument as a whole, comprising 16 items. The conventional acceptability criterion used was 0.70 [8].

Table 3. Cronbach's alpha and corrected item-total correlations by construct.

Construct	Cronbach's α	95% CI	Item	Corr. item-total r
People Synchronisation	0.137	[–0.104, 0.336]	PS1 / PS2 / PS3 / PS4	0.048 / 0.065 / –0.017 / 0.171
Process Synchronisation	0.199	[–0.024, 0.384]	PR1 / PR2 / PR3 / PR4	0.063 / –0.008 / 0.243 / 0.101
Business Environment	0.222	[0.005, 0.402]	BE1 / BE2 / BE3 / BE4	0.126 / 0.248 / 0.086 / –0.011
Project Management Effectiveness	0.118	[–0.128, 0.322]	PME1 / PME2 / PME3 / PME4	0.074 / –0.009 / 0.122 / 0.040
Overall scale (16 items)	–0.070	—	—	—

According to Table 3, all four constructs failed to reach the standard reliability level. People Synchronisation had $\alpha = 0.137$, Process Synchronisation $\alpha = 0.199$, Business Environment $\alpha = 0.222$, and Project Management Effectiveness $\alpha = 0.118$. For completeness, the Cronbach's alpha calculated across all 16 items was –0.070.

Since the questionnaire was designed to represent four separate constructs, the construct-specific alpha values are more relevant for assessing internal consistency. Moreover, the corrected item-total correlations suggest poor internal consistency. For the four constructs, they ranged from -0.017 to 0.248 , below the desirable 0.30 criterion for item inclusion in a construct. These results mean that individual items did not consistently covary with their construct scores. Therefore, reliability issues pose an important initial problem for using this measure as an instrument for latent variable modelling.

4.4. Sampling Adequacy: KMO and Bartlett's Test

Given the low reliability values, it was important to check whether the correlation matrix showed enough common variance to support further EFA. Thus, the KMO statistic and Bartlett's test of sphericity were computed before making any conclusions regarding the results of the factor structure [9], [10]. The KMO statistic was 0.491 , below the conventional minimum of 0.50 , indicating inadequate sampling adequacy for factor analysis [9]. Additionally, Bartlett's test of sphericity was non-significant ($\chi^2 = 127.31$, $df = 120$, $p = 0.307$). As a result, the null hypothesis stating that the 16-item correlation matrix is an identity matrix cannot be rejected. Overall, the statistics indicate that the items did not show enough common variance to support a reliable factor structure. This agrees with the Cronbach's alpha results in Table 3 and serves as a fundamental diagnostic criterion for the further factor analysis presented in Section 4.5.

4.5. Exploratory Factor Analysis

Although the KMO and Bartlett's test results indicated inadequate factorability, an EFA was conducted as a diagnostic analysis to examine how the items behaved under the proposed four-factor specification. The EFA used the Principal Axis Factoring extraction method and Promax rotation, with an initial definition of four factors consistent with the measurement model. Table 4 presents the rotated factor-loading matrix, and Fig. 2 shows the eigenvalue scree plot.

Table 4. Rotated factor loadings, exploratory factor analysis (principal axis, promax).

Item	F1	F2	F3	F4
PS1	0.248	0.189	0.150	-0.435
PS2	-0.014	0.106	0.245	-0.072
PS3	-0.432	-0.171	0.135	0.044
PS4	0.023	0.035	0.615	-0.019
PR1	-0.057	0.285	-0.521	0.313
PR2	-0.542	-0.223	-0.089	-0.040
PR3	-0.034	0.229	-0.239	0.627
PR4	0.035	0.121	0.268	0.605
BE1	0.511	-0.194	-0.086	0.386
BE2	0.710	-0.265	0.094	-0.051
BE3	0.384	0.041	-0.388	-0.149
BE4	-0.074	-0.595	-0.106	-0.190
PME1	-0.100	0.604	-0.136	0.017
PME2	-0.055	0.061	0.579	0.385
PME3	0.172	0.427	0.127	0.034
PME4	-0.175	0.364	-0.009	-0.328

As shown in Table 4, the factor-loading structure did not match the hypothesized four-component simple structure. Items expected to measure the same component were often distributed across different factors, and some had near-zero or even negative loadings. Because the loading pattern was inconsistent, we conclude that the PS, PR, BE, and PME structure did not adequately represent the true relationships among items. The eigenvalue distribution also provides further evidence that the proposed structure was difficult to obtain.

As shown in Fig. 2, seven of the 16 eigenvalues exceed 1.0 by the Kaiser criterion. However, the specified four-factor solution accounted for 37.0% of the variance across the 16 items. Combined with the previous problems identified through reliability, KMO, and Bartlett analyses, this confirms our assumptions about the structure's inconsistency. In summary, the EFA analysis provides no empirical evidence to support the hypothesis of a four-factor structure for the measures used. Instead, it suggests that the measures failed to form coherent factors in the current sample. This result is especially important for further application of CFA and SEM.

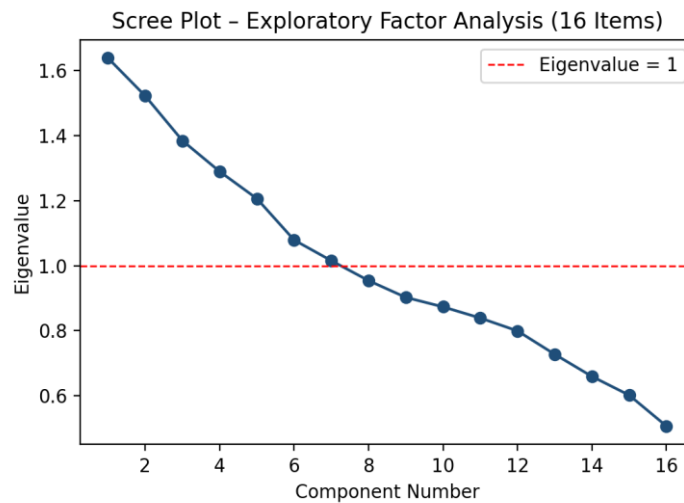


Fig. 2. Scree plot of eigenvalues for the 16 items.

4.6. Correlation Analysis

Accordingly, Pearson correlation analysis was conducted using the composite scores of the four identified constructs. This was done to determine the nature and extent of correlation among the constructs PS, PR, BE, and PME. The complete correlation matrix is shown in Table 5 below, and the correlation graph is shown in Fig. 3 below. Given the very low internal consistency and the failure to establish the intended factor structure, these correlations are best interpreted as associations among the observed composite scores rather than as reliable estimates of relationships among the underlying constructs.

Table 5. Pearson correlation matrix of construct scores (N = 160, $p < .05$).

	PS	PR	BE	PME
PS	1.000	-0.140	-0.125	0.066
PR	-0.140	1.000	0.008	-0.008
BE	-0.125	0.008	1.000	-0.158*
PME	0.066	-0.008	-0.158*	1.000

Table 5 presents the Pearson correlations among the four construct scores. The expected relationships are generally weak. The correlation between PS and PME is $r = 0.066$ ($p = 0.411$), while the correlation between PR and PME is $r = -0.008$ ($p = 0.918$); neither correlation is statistically significant. The correlation between BE and PME is $r = -0.158$ ($p = 0.047$), which is statistically significant at the 5% level but runs opposite to the direction hypothesised under H3.

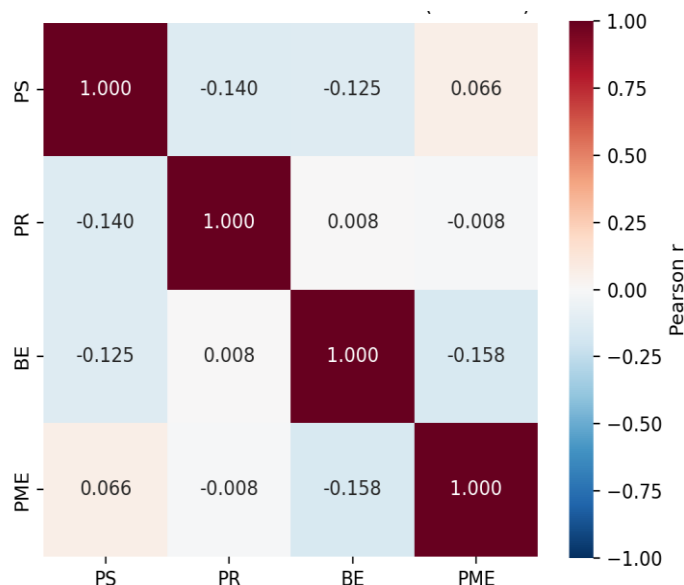


Fig. 3. Inter-construct correlation heatmap (Pearson r , N = 160).

The correlations among the three predictors are also weak. PS and PR correlate at $r = -0.140$ ($p = 0.078$), PS and BE at $r = -0.125$ ($p = 0.115$), and PR and BE at $r = 0.008$ ($p = 0.923$). Weak relations between the predictors provide no evidence of multicollinearity at the composite score level and no empirical support for the system of constructs discussed above. The pattern in Fig. 3 is consistent with the numerical results in Table 5: the associations between the constructs are mostly weak. The weak observed associations do not provide support for H1–H3. However, given the measurement problems identified above, they should not be interpreted as evidence that the underlying constructs are unrelated.

4.7. Confirmatory Factor Analysis and Structural Equation Model

In the second stage of the analysis, the empirical adequacy of the four-factor measure model was evaluated using CFA, while the testability of the hypothesized structural relationships was analyzed using SEM. The four-factor measure model consisted of the following latent factors: PS, PR, BE, and PME, each measured by four observed variables. In the estimation of the CFA, the Maximum Likelihood estimation method was applied. In contrast, the structural relations were estimated by regressing PME on PS, PR, and BE. The construct scores showed some departure from normality, although the reported skewness and kurtosis values were relatively modest. The CFA and SEM results were therefore interpreted with caution, particularly in view of the measurement problems identified in the model.

Table 6. Model fit indices, hypothesised four-factor CFA/SEM Model (N = 160).

Fit index	CFA (measurement model)	SEM (structural model)	Benchmark [11]
χ^2 (df)	95.12 (98)	95.12 (98)	Non-significant preferred
χ^2 p-value	0.564	0.563	$p > .05$
CFI	1.217	1.217	$\geq .95$
TLI	1.266	1.265	$\geq .95$
GFI	0.286	0.286	-
AGFI	0.126	0.126	-
RMSEA	0.000	0.000	$\leq .06$

From the CFA results in Table 6, the four-factor measurement model did not provide a feasible or theoretically sound fit. Although the model yielded a non-significant chi-square value ($\chi^2(98) = 95.12$, $p = 0.564$), other fit indices suggest considerable problems. First, the Comparative Fit Index (CFI = 1.217) and the Tucker–Lewis Index (TLI = 1.266) exceed the theoretical limit of 1.00. In contrast, the Goodness-of-Fit Index (GFI = 0.286) and the Adjusted Goodness-of-Fit Index (AGFI = 0.126) are both below the conventional minimum of 0.90. RMSEA was found to be equal to 0.000. However, RMSEA alone cannot prove an appropriate fit, as the other fit indices clearly suggest measurement problems.

Moreover, the parameter estimates further indicate measurement problems. Three indicators, PS1, BE1, and PME1, had zero variance, indicating a Heywood case. This inadmissible solution raises concerns about the measurement model's stability. The current findings agree with previous reliability tests, KMO/Bartlett, and EFA, which also failed to establish sufficient common variance and a four-factor structure.

Table 7. Structural path estimates, SEM (N = 160).

Path	Estimate	S.E.	z-value	p-value	Decision
PME ← PS	0.137	0.330	0.417	0.677	H1 not supported
PME ← PR	1.132	0.851	1.330	0.183	H2 not supported
PME ← BE	-0.141	0.297	-0.476	0.634	H3 not supported

None of the structural paths shown in Table 7 yielded statistically significant relationships between the predictor constructs and Project Management Effectiveness. The path from PS to PME was positive but non-significant (estimate = 0.137, SE = 0.330, $z = 0.417$, $p = 0.677$), providing no evidence in support of H1. Similarly, the path from PR to PME was positive but non-significant (estimate = 1.132, SE = 0.851, $z = 1.330$, $p = 0.183$), providing no evidence in support of H2. The path from BE to PME was negative and non-significant (estimate = -0.141, SE = 0.297, $z = -0.476$, $p = 0.634$), so H3 was also not supported by the data.

Although the measurement model did not yield an admissible solution, the estimated structural paths are reported as diagnostic results rather than as definitive tests of the hypothesized latent-variable relationships. The paths are presented in full to ensure transparent reporting of the obtained results. Given the inadmissible measurement model, the non-significant structural path estimates should therefore be interpreted cautiously. They should not be taken as definitive evidence against the hypothesized PS–PR–BE–PME relationships. The measurement model did not yield a stable four-factor structure, and none of the three structural paths were statistically significant.

This means the current findings do not show that People Synchronisation, Process Synchronisation, and Business Environment serve as statistically significant latent predictors of Project Management Effectiveness. Due to these limitations of the measurement model, a multiple regression analysis based on composite scores was conducted.

4.8. Composite-Score Multiple Regression (Sensitivity Analysis)

Considering the inadmissibility of the CFA/SEM model solution based on the latent variables, a multiple regression analysis based on the composite means of the four variables was conducted as a sensitivity test through ordinary least squares (OLS). This procedure provides another opportunity for assessing the hypothesized relationship between the variables independently of the problematic latent-variable measurement model. The reported diagnostics were limited to multicollinearity and residual autocorrelation. The regression was therefore treated as a supplementary sensitivity analysis rather than a definitive test of the hypothesized relationships. Table 8 provides the regression coefficients, their standard errors, significance levels, and variance inflation factors.

Table 8. Multiple regression, Dependent variable: PME_Score (N = 160). $R^2 = .027$; Adjusted $R^2 = .008$; $F(3,156) = 1.440$, $p = .233$; Durbin-Watson = 1.976.

Predictor	Unstd. β	S.E.	t	p-value	VIF
(Constant)	4.434	0.552	8.039	<0.001	—
PS_Score	0.044	0.075	0.578	0.564	1.036
PR_Score	-0.001	0.073	-0.006	0.995	1.020
BE_Score	-0.135	0.071	-1.906	0.059	1.016

Table 8 shows that the overall regression model was not statistically significant, with $R^2 = 0.027$, Adjusted $R^2 = 0.008$, $F(3,156) = 1.440$, $p = 0.233$. Therefore, PS, PR, and BE jointly explained only 2.7% of the variance in PME. The adjusted R^2 indicates that the regression model has little explanatory power after adjusting for the number of predictors. None of the three predictors was found to be statistically significant at $\alpha = .05$ level. Particularly, PS_Score was positively associated with PME_Score but insignificantly ($\beta = 0.044$, $t = 0.578$, $p = 0.564$). PR_Score had little or even no association with PME_Score ($\beta = -0.001$, $t = -0.006$, $p = 0.995$). BE_Score had a negative but insignificant association with PME_Score ($\beta = -0.135$, $t = -1.906$, $p = 0.059$).

The reported diagnostics did not indicate problematic multicollinearity or residual autocorrelation. VIF values ranged from 1.020 to 1.036, indicating no significant multicollinearity among the predictors. The Durbin-Watson statistic was equal to 1.976, meaning no significant autocorrelation in residuals. However, despite these diagnostics, the lack of statistical significance and insignificant adjusted R^2 suggest the data did not support the predictor structure in the present study.

4.9. Subgroup Comparisons (ANOVA and t-Test)

To examine whether Perceived Project Management Effectiveness varied systematically across respondent profiles, we conducted subgroup analyses using one-way ANOVA and an independent-samples t-test. Table 9 presents the subgroup analysis findings by respondent profile, while Figs. 4 and 5 visually represent respondent distribution by experience band and project type, respectively.

Table 9. One-way ANOVA and independent-samples t-test results for PME_Score.

Comparison	Test statistic	df	p-value	Result
PME_Score by Experience Band	$F = 0.439$	4, 155	0.780	Not significant
PME_Score by Department	$F = 0.552$	14, 145	0.898	Not significant
PME_Score by Project Type	$F = 0.289$	5, 154	0.918	Not significant
PME_Score: Low vs. High Experience	$t = 1.193$	158	0.235	Not significant

ANOVA tests for PME_Score across three dimensions show that none were significant. Specifically, the comparison of experience band gave $F = 0.439$, $df = 4, 155$, $p = 0.780$. The comparison of departments was also non-significant ($F = 0.552$, $df = 14, 145$, $p = 0.898$), while project type was also non-significant ($F = 0.289$, $df = 5, 154$, $p = 0.918$). Taken together, these results imply that respondents' perceptions of project management effectiveness did not differ significantly by experience band, functional department, or project type.

The mean differences in PME_Score were tested using an independent-samples t-test, dividing the sample into two groups of 80 respondents based on an experience cut-off of 15.5 years. Respondents with experience at or below the median ($n = 80$) had a PME_Score of 4.134 ($SD = 0.443$), while those with experience above the median had a PME_Score of 4.041 ($SD = 0.546$). There was no statistically significant difference between the two subgroups, $t = 1.193$, $p = 0.235$.

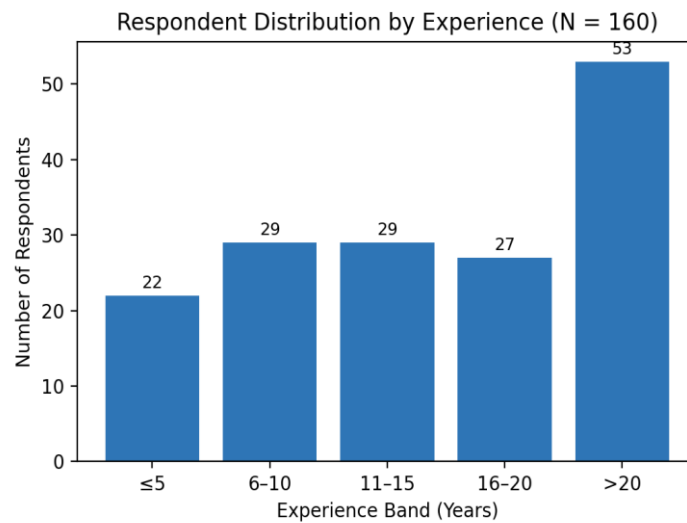


Fig. 4. Respondent distribution by experience band (N = 160).

Fig. 4 depicts the number of respondents in each of the five experience groupings. Fig. 4 supplements Table 1 by showing that more respondents have over 20 years of experience.

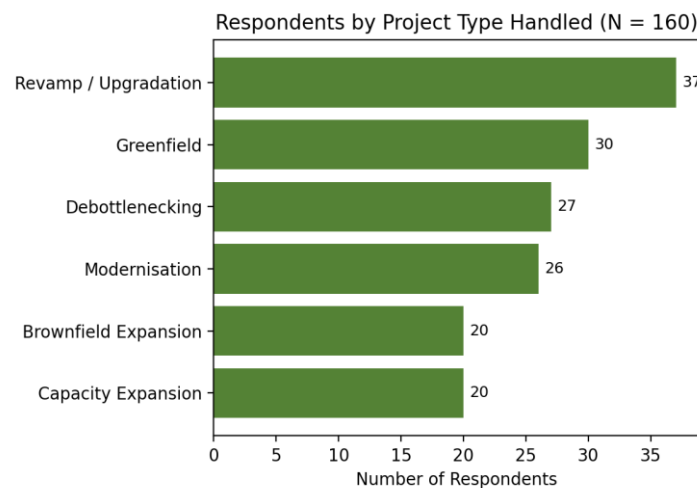


Fig. 5. Respondent distribution by project type handled (N = 160).

Distribution of Respondents by Type of Project is shown in Fig. 5. This distribution correlates with the project representation described in detail in Table 1. Revamp/Upgradation is the largest project type, followed by Greenfield, Debottlenecking, and Modernisation. Combining the ANOVA and t-test results, differences in PME among the main demographic and project-related subgroups of the population under consideration cannot explain the lack of support for the relationships suggested in this research.

4.10. Qualitative Strand: Documentary Content Analysis

The qualitative strand used a directed documentary content analysis of secondary sources relevant to project execution in the Indian steel and construction industries. The review examined the sources deductively against the three predictive constructs of the proposed framework: PS, PR, and BE. The analysis identified recurring themes and mapped them to the relevant constructs, as summarised in Table 10. Because this strand used documentary evidence rather than primary qualitative data, it aimed to provide contextual and conceptual interpretation of the quantitative findings rather than independently validate the proposed measurement model. The evidence in Table 10 highlights several recurring themes relevant to the framework under development.

Regarding Process Synchronisation, documentary evidence points to the fragmented, siloed nature of delivery models as a limitation on predictability. In contrast, industry analyses argue for standardising designs and digitalisation to counter implementation risks posed by India's capacity expansion [1]. The evidence captures both people and process dimensions, linking timeline risk in Indian steel projects to capital and process constraints and cross-functional coordination issues, where the relative significance of these aspects depends on the specific project category [6].

Critical-success-factors literature beyond this case reinforces the conceptual relevance of synchronisation across human, process, and external domains [2], [3]. There is also documentary evidence about the effect of external and sustainability factors on the relationship between human and process dimensions [5]. The distinction between people-based and process-based success factors conceptually justifies distinguishing between People Synchronisation and Process Synchronisation [4].

Table 10. Themes from documentary qualitative content analysis, mapped to model constructs.

Construct informed	Theme identified	Illustrative documentary evidence
PR	Fragmented, siloed delivery models limit predictability	Industry analysis of India's capacity build-out attributes execution risk to fragmented delivery and calls for design standardisation and digital integration to restore predictability [1]
PS + PR	Human-process interaction drives timeline risk	Sector-specific review finds new-project timeline risk in Indian steel driven jointly by capital/process constraints and cross-functional coordination difficulty, varying by project type [6]
PS + PR + BE	CSFs must be synchronised across human, procedural and external categories	Applied CSF frameworks for project management practice converge on project-action, procedural, human and external-environment categories that must be synchronised for on-time delivery [2], [3]
BE	External/sustainability conditions moderate the human-process relationship.	CSF research in developing-country construction contexts shows external and sustainability-related conditions increasingly moderate how human and procedural factors jointly affect outcomes [5]
PS	Distinct people-centred vs. process-centred success levers	The foundational ten-factor implementation model separates strategic/procedural factors (scheduling, monitoring) from people-centred factors (personnel, communication), supporting PS and PR as conceptually distinct dimensions [4]

An interesting point is the comparison between the documentary and quantitative evidence streams. As shown in Table 10, the reviewed documentary evidence finds the PS-PR-BE framework conceptually relevant for project execution in Indian heavy industry. However, this conceptual validity is not empirically reflected in psychometric or structural validation within the primary survey dataset. None of the reviewed sources reports psychometric validation of any survey instruments similar to the one used here in this industry context. Sections 5.2 and 5.3 discuss this discrepancy between the documentary and quantitative evidence further.

5 DISCUSSION

This chapter interprets the findings in the context of the study's research questions, hypotheses, and theoretical basis. It begins by synthesizing the key findings, then analyses the documentary data to interpret the statistical results. The chapter then examines possible reasons for the null and inadmissible findings from a methodological and measurement perspective, then places the findings in the wider context of existing literature. It specifically highlights the distinction between the conceptual relevance of the PS-PR-BE-PME framework in the literature and the empirical findings from the instrument used in the current study.

5.1. Summary of Quantitative Findings

Across all diagnostic tests applied, including Cronbach's alpha, item-total correlation, KMO, Bartlett's test of sphericity, EFA, inter-construct correlation, CFA, and structural path analysis, one consistent finding emerged. The 16-item scale applied to this specific sample does not measure four distinct and internally consistent latent constructs. Thus, this sample provides no reliable basis for drawing substantive conclusions about the hypothesized relationships between People Synchronisation, Process Synchronisation, Business Environment, and Project Management Effectiveness. This is not because of any one poor indicator or underpowered structural path, but because of a consistent lack of shared variance between the 16 items and 160 individuals in the sample.

5.2. Documentary Contextual Analysis

To interpret the quantitative null results, the directed documentary content analysis in Section 4.10, summarised in Table 10, serves as the qualitative component of this mixed-methods design. The documentary review further underlines that people-, process-, and environment-oriented variables are, in general, collectively important for successful project outcomes in this industry. The industry-specific analysis of capacity building in India explicitly identifies fragmented, siloed delivery as a source of risk. It highlights the need to standardise design and integrate digital systems to synchronise processes and restore predictability [1].

Also, the project management analysis of the Indian steel industry clearly demonstrates that the timeline risk comes as a result of capital and process constraints and the difficulties related to coordinating various types of projects such as greenfield, modernization, and expansion, which, therefore, represents the people-and-process factor interaction instead of a technical one [6]. Finally, the broader CSF literature, which informed the design of the PS-PR-BE-PME framework, views project success factors as human-, procedural-, and external environment-related categories that must be synchronised for timely delivery [2], [3], [5]. Taken together, the documentary evidence supports the conceptual relevance of the proposed theoretical model, although the primary survey data did not statistically support it. This difference is essential because it distinguishes the conceptual validity of the constructs in the existing literature from their measurement performance in the current study.

5.3. Probable Causes of the Null / Inadmissible Result

Various methodological factors, individually or jointly, may explain the observed lack of reliability and the absence of structural relationships.

(i) Common-method and social-desirability bias: Single-source self-report cross-sectional Likert-type data are prone to common-method variance that may cause overestimation of associations, or, in the case of low variability of uniformly positive answers provided on dissimilar items, result in covariation compression to zero. This is consistent with the present results [12]. Also, the relatively small range of means for constructs (from 3.88 to 4.09) and standard deviations around 0.5 are indicative of ceiling compression and possibly poor discrimination.

(ii) Wording and indicator-construct mismatch: As Bartlett's test suggests the correlation matrix does not deviate from the identity matrix, it is possible that each of the individual items, despite being grouped into one construct in the instrument development, was viewed as distinct issues by the respondent, i.e., did not reflect a single construct. This is an expected problem when items are developed quickly from CSFs without going through the instrument development process, including item creation, expert evaluation, pretesting, and item purification.

(iii) Heterogeneity of the sample and organizations: The sample covers 21 organizations, 15 departments, and six kinds of projects. While this variety provides a broad context, it also suggests that a fixed-item scale may not perform equally well across heterogeneous positions without a measurement invariance test, which cannot be conducted due to poor baseline reliability.

(iv) Sample size relative to model complexity: The study included 160 respondents for a four-factor model with 16 observed indicators. Although this sample provides a basis for estimating the specified model, the adequacy of the sample cannot be judged by a simple respondents-per-parameter rule alone. In the present study, the very low communalities and weak relationships among the items are more important concerns for the stability of the factor solution. A larger sample may provide more stable estimates, particularly when the underlying covariance structure is weak [14].

5.4. Interpretation Relative to Prior Literature

Failure to support H1–H3 hypotheses in this work does not contradict the existing CSF literature. Rather, it shows that the specific tool, used only once in a cross-sectional context for the given sample, failed to operationalize constructs that the literature on this subject has previously validated [2]–[6]. This distinction matters for determining how this study's outcomes can be used. These outcomes provide a starting point for further tool improvement and testing, but they do not prove the hypothesis that alignment among people, process, and environment does not occur. Presenting the analysis outcomes, including the Heywood-case CFA solution and the statistically non-significant SEM paths, supports transparent reporting of findings that do not support the hypothesised relationships [7]. This is particularly important in applied management science, where empirical evidence may affect decisions related to capital projects.

6 THEORETICAL AND MANAGERIAL IMPLICATIONS

This section examines the implications of the study's results for project management theories and practices in the Indian steel industry. Given the inadmissibility of the measurement model and the lack of confirmation for the proposed relationships, the implications are drawn cautiously. These results do not reduce the relevance of the conceptualization of the people, process, and environment elements.

6.1. Theoretical Implications

This study contributes to the CSFs and PME literature by fully reporting inadmissible psychometric results on heavy industry in India. Such results remain comparatively underrepresented in the literature compared with statistically significant findings, mainly because empirical publication tends to favour positive results and acceptable model fit. Therefore, the study highlights the usefulness of reporting non-supportive and inadmissible results, rather than only the data used for the respective measurement or structural models.

Methodologically, the findings highlight the importance of conducting reliability checks, KMO/Bartlett's test, EFA, CFA, and SEM before interpreting the structure. Each step alone shows evidence of the measurement problem. Failing to check reliability and sampling adequacy would have led to the inadmissible CFI above 1.0 being interpreted as acceptable model fit. The sequential validation process is thus necessary to ensure structurally estimated results are interpreted correctly, especially when the measurement model is not empirically defensible. The study operationalizes PME as schedule adherence, budget adherence, quality, and delivery satisfaction. This multidimensional operationalization is broadly consistent with the performance-oriented view of project outcomes reflected in project management practice guidelines [15]. However, this sample does not statistically confirm the theoretical basis of the operationalized outcome constructs and their relationships.

6.2. Managerial Implications

For project organizations in the steel industry, the document analysis in Section 5.2 confirms the need to invest in cross-functional coordination activities, standardized process documentation, and business-environment scanning capabilities. These activities still relate to execution predictability in the existing literature, even though the present study did not provide statistical proof of this conceptual and practical relationship. From the perspective of project management research and the design of similar diagnostic tools in organizations' human resource and quality assurance functions, the results emphasize the importance of following a formal scale-development process before implementing the checklist. This process must include expert review of content validity, cognitive pretesting, pilot testing, and revision of individual items. Hence, the results imply the dangers of using purely face-valid CSFs without further transforming them into Likert-scale items.

7 LIMITATIONS AND FUTURE RESEARCH

This section outlines and discusses the primary limitations of the current research, as well as possible directions for further research based on the empirical findings and methodology. These limitations matter because the study's measurement model showed low reliability and validity, suggesting that the quantitative results should be interpreted in the context of the specific sample and data collection methods used. Therefore, future research should focus on improving measurement development and triangulation, reducing common method variance, and testing the PS-PR-BE-PME model.

7.1. Limitations

Finally, although the study obtained 160 valid responses from 21 firms, the sample was not proportional by firm size, project value, or geographical location, which limits the generalisability of the findings. Since more than one respondent was drawn from some firms, the responses may also reflect shared organizational conditions. This should be considered when interpreting the statistical results.

7.2. Future Research

Future research should address several methodological improvements. First, the survey instrument should be redeveloped using an established scale-development methodology that includes panel review of the scale items and cognitive interviewing before field implementation. Second, the improved instrument should be piloted with a sample of about 30–50 participants, followed by item purification based on item-total correlations and EFA before confirmatory testing. Third, future research should collect primary data through semi-structured interviews with selected project leaders in the same or similar organizations. In other words, future research ought to retain an explanatory sequential mixed-methods design but replace the documentary qualitative strand with field-based qualitative data, such as semi-structured interviews with selected project leaders, to provide deeper contextual explanations for anomalies identified in the quantitative results. Fourth, future research ought to use multi-source data collection by combining self-reported PME measures with objective data, such as the project leader's schedule and cost variances, to reduce the common-method variance problem. Finally, measurement invariance should be tested across departments and projects before analyzing responses in a single structural model.

8 CONCLUSION

This research examines the hypothesized relationships between People Synchronisation, Process Synchronisation, Business Environment, and Project Management Effectiveness in projects from Indian steel sector companies using a mixed-method design, with quantitative methods as dominant. A survey of 160 participants from 21 organisations was conducted; additionally, a documentary qualitative analysis was performed. The full sequence of psychometric and structural analyses, including reliability tests, KMO and Bartlett's test for sampling adequacy, EFA, CFA, SEM, and composite score regression, consistently led to these conclusions. The applied scale did not reveal its expected four-factor structure, and the structural relationships hypothesised by H1-H3 were statistically insignificant.

Instead of adjusting the statistical analysis to produce acceptable results, the study reported the obtained results, including the non-admissible Heywood-case CFA solution, and interpreted them alongside the documentary evidence that provides contextual support for the conceptual relevance of people-process-environment synchronisation in Indian steel sector companies. Thus, the study's main value lies in its methodology and diagnosis. The study highlights the need to further develop and validate the measurement scale, along with a mixed-methods design incorporating primary qualitative data, to provide stronger evidence to confirm or refute the PS-PR-BE-PME model in the context of Indian steel industry project management. This study also presents a structured analytical process, including statistical calculations and SEM diagnostics.

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DATA PROTECTION AND PRIVACY

The study collected no personal identifiers, such as names, addresses, telephone numbers, or unique identifiers assigned to employees. The responses were tabulated, and the company names provided in Section 4.1 were used only for descriptive purposes.

ETHICS STATEMENT

In this study, participants were working professionals who completed an anonymous, voluntary questionnaire. Participation was voluntary and anonymous, and respondents were informed in advance that the study was academic in nature. Consent was implied through participants' voluntary, anonymous completion and submission of the questionnaire.

STATEMENT OF CONFLICT OF INTERESTS

The authors declare no conflicts of interest related to this study.

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LICENSING

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REFERENCES

- [1] MKPMG in India, "Building India's next 100 MTPA—Embedding execution excellence in steel projects," KPMG in India, May 8, 2026. [Online]. Available: <https://kpmg.com/in/en/insights/2026/05/building-indias-next-100-mtpa-embedding-execution-excellence-in-steel-projects.html>
- [2] Z. Alias, E. M. A. Zawawi, K. Yusof, and N. M. Aris, "Determining Critical Success Factors of Project Management Practice: A Conceptual Framework," *Procedia - Social and Behavioral Sciences*, vol. 153, pp. 61–69, Oct. 2014, doi: 10.1016/j.sbspro.2014.10.041.
- [3] V. Sanvido, F. Grobler, K. Parfitt, M. Guvenis, and M. Coyle, "Critical success factors for construction projects," *Journal of Construction Engineering and Management*, Mar. 1992, doi: 10.1061/(ASCE)0733-9364(1992)118:1(94).
- [4] J. K. Pinto and D. P. Slevin, "Critical factors in successful project implementation," in *IEEE Transactions on Engineering Management*, vol. EM-34, no. 1, pp. 22–27, Feb. 1987, doi: 10.1109/TEM.1987.6498856.
- [5] S. Banihashemi, M. R. Hosseini, H. Golizadeh, and S. Sankaran, "Critical success factors (CSFs) for integration of sustainability into construction project management practices in developing countries," *International Journal of Project Management*, vol. 35, no. 6, pp. 1103–1119, Feb. 2017, doi: 10.1016/j.ijproman.2017.01.014.
- [6] S. Kumar and V. Kumar, "Effective project management in steel industry," *Asian Journal of Management*, vol. 8, no. 4, pp. 1379–1386, 2017, doi: 10.5958/2321-5763.2017.00210.4.
- [7] A. H. Al-Hoorie, Y. In'nami, and P. Hiver, "Fit-hacking: Questionable research practices in structural equation modeling," *Studies in Second Language Acquisition*, vol. 48, no. 2, pp. 513–534, 2026, doi: 10.1017/S0272263126101569.
- [8] J. C. Nunnally, *Psychometric Theory*, 2nd ed. New York, NY, USA: McGraw-Hill, 1978.
- [9] H. F. Kaiser, "An index of factorial simplicity," *Psychometrika*, vol. 39, no. 1, pp. 31–36, 1974, doi: 10.1007/BF02291575.
- [10] M. S. Bartlett, "A note on the multiplying factors for various chi-square approximations," *Journal of the Royal Statistical Society: Series B (Methodological)*, vol. 16, no. 2, pp. 296–298, 1954, doi: 10.1111/j.2517-6161.1954.tb00174.x.
- [11] L. T. Hu and P. M. Bentler, "Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives," *Structural Equation Modeling: A Multidisciplinary Journal*, vol. 6, no. 1, pp. 1–55, 1999, doi: 10.1080/10705519909540118.

- [12] P. M. Podsakoff, S. B. MacKenzie, J.-Y. Lee, and N. P. Podsakoff, “Common method biases in behavioral research: A critical review of the literature and recommended remedies,” *Journal of Applied Psychology*, vol. 88, no. 5, pp. 879–903, 2003, doi: 10.1037/0021-9010.88.5.879.
- [13] J. W. Creswell and V. L. Plano Clark, *Designing and Conducting Mixed Methods Research*, 3rd ed. Los Angeles, CA, USA: SAGE, 2018.
- [14] R. B. Kline, *Principles and Practice of Structural Equation Modeling*, 4th ed. New York, NY, USA: Guilford Press, 2016.
- [15] Project Management Institute, *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 7th ed. Newtown Square, PA, USA: Project Management Institute, 2021.