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MULTI-ITEM SCALE CONSTRUCTION TO MEASURE THE CONTRIBUTION OF DIFFERENT RISKS IN CONSTRUCTION PROJECTS OF OIL & GAS INDUSTRY

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Abstract:

Risk management is a crucial element in ensuring the success of construction activities in the oil and gas sector, which are inherently complex and susceptible to numerous risks. This study aims to develop a scale of multiple items to evaluate the contribution of different types of risk towards the total risk of an oil and gas construction project. A structured questionnaire was distributed among industry professionals and academicians, capturing their insights on risk impact and likelihood. The reliability analysis has been performed in SPSS software, and confirmatory factor analysis (CFA) has been performed in AMOS software. Findings highlight that scaled 13 risks cover all the important segments of the construction project in 3 categories. It is also observed that the individual impact of risk groups like fin & tech, project management, and procurement is maximum on total risk rather than the combination of these three.

Keywords: Amos, Oil and gas construction, Risk impact, Scale development, SPSS.

I. Introduction

Risk identification is a critical component of project risk management, serving as the initial step in recognizing potential uncertainties that may affect project objectives. In complex sectors such as oil and gas construction, effective risk identification enables proactive planning and informed decision-making. This process typically integrates expert judgment, historical data, and structured methodologies to uncover both conventional and emerging threats.

To ensure relevance and alignment with organizational and regulatory priorities, risk identification employs a combination of qualitative and quantitative approaches.

Insights from expert consultations, past project records, and industry benchmarks are systematically analysed. Techniques such as workshops, Delphi surveys, and stakeholder engagement are instrumental in capturing diverse risk perspectives. Documenting identified risks through a structured risk register facilitates impact analysis and mitigation planning. As projects evolve, these registers are periodically updated to reflect new insights, changing technologies, and dynamic external conditions.

In the context of oil and gas construction, internal risks are particularly significant due to their direct influence on project execution and cost performance. These can be broadly categorized into two clusters. The first includes political and economic uncertainties, regulatory dynamics, and interactions with local communities—factors particularly relevant in cross-border and resource-sensitive environments. Technical risks in this group relate to engineering design, contract management, manpower and material availability, and execution complexity.

The second cluster relates to stakeholder-driven risks, including physical risks such as environmental hazards, site security challenges, and force majeure events like natural disasters. These risks have a cascading effect on project cost, schedule, quality, and, in severe cases, project continuation.

To investigate these risks empirically, this study conducted a structured questionnaire survey based on insights from prior literature and contextual field knowledge. A total of nine primary risk categories and seventy-three specific risk subcategories were identified. These classifications were developed in consultation with domain experts and supported by prior frameworks (Mojtahedi et al., 2009; Cleden, 2009), ensuring that the survey instrument reflects both theoretical comprehensiveness and practical relevance.

This research is guided by two principal aims. Firstly, it seeks to identify and conceptualize the core dimensions that constitute the latent construct of construction project risk (Rcp). Secondly, it endeavours to develop and empirically validate a multi-item measurement scale specifically designed to assess Rcp within the context of oil and gas construction projects.

The conceptualization of Rcp was initiated through a comprehensive review of existing risk classification frameworks and domain-specific studies, such as those by PMI (2017), ISO 31000 (2018), and ANP-based risk models (e.g., Erol et al., 2022). While these models provide robust taxonomies and decision-support structures, they often focus on broad categories or qualitative checklists, lacking empirical scale validation or psychometric rigor tailored for oil and gas construction settings. Moreover, they tend to aggregate risk factors at a high level without capturing the multi-dimensional, latent structure of how different risks interact and contribute to project outcomes in this complex sector.

In contrast, the present study distinguishes itself by developing a quantitatively validated, multi-item Rcp scale that captures the perceived intensity and contribution of specific construction risks, grounded in the lived experiences of practitioners in oil and gas megaprojects. This scale is not a direct adaptation of existing frameworks but is empirically derived, ensuring contextual sensitivity and psychometric soundness.

The Rcp scale goes beyond descriptive classification by providing a validated measurement tool for both academic analysis and managerial application.

Several prior studies have informed the methodological approach to scale development and validation. For example, Kautish et al. (2020) created a multi-item instrument to evaluate online consumption emotion (OCE); Park et al. (2024) validated a six-dimensional scale to assess attitudes toward AI; and Colwell et al. (2008) and Tuck and Thompson (2023) adopted similar procedures for scale development in marketing and social behaviour contexts. However, these studies are outside the construction and infrastructure domains, and none provide a validated instrument specifically targeting construction risk measurement.

Despite valuable contributions across various fields, a notable research gap persists in the systematic measurement of risk constructs within construction projects, particularly in the oil and gas sector. Therefore, this study addresses that gap by developing and validating a domain-specific Rcp scale to quantify how different risk factors influence construction project performance.

I.i. Distinction from Existing Risk Frameworks

Despite the existence of several established risk classification models—such as the Project Management Institute (PMI, 2017) risk categories, ISO 31000 (2018) guidelines, and analytic frameworks like the Analytic Network Process (ANP)—these approaches primarily function as taxonomical or qualitative checklists. They broadly categorize risk types (e.g., financial, technical, regulatory) without offering empirically validated measurement scales that capture how these risks are perceived and experienced in real-world construction environments, particularly within the oil and gas sector.

In contrast, the present study introduces a domain-specific, psychometrically validated Rcp scale that provides a quantitative assessment of latent risk perceptions across three empirically derived dimensions: Financial and Technical Risk, Project Management and Contractual Risk, and Procurement & Regulatory Compliance Risk. Unlike traditional frameworks, this scale does not merely classify risks, but rather measures their relative influence on project outcomes through a rigorously tested multi-item instrument using factor analysis.

Moreover, while frameworks such as ISO 31000 emphasize risk process principles and organizational context, they often lack granularity in sector-specific risk profiling. Similarly, previous academic studies often aggregate risk at high conceptual levels without addressing construct validity, inter-item reliability, or dimensional intercorrelation. This research addresses that gap by operationalizing Rcp as a latent construct with validated sub-dimensions, enabling both researchers and practitioners to benchmark, compare, and track risk exposure using a standardized tool.

Thus, the Rcp scale stands apart by integrating the strengths of traditional risk categories with the rigor of modern psychometric validation, creating a practical and research-backed tool specifically tailored for the complexity and volatility of oil and gas construction projects.

II. Types of risks in construction projects of Oil and Gas Industry

Construction projects in the oil and gas sector are uniquely exposed to a constellation of risks due to their capital intensity, technical complexity, and geopolitical sensitivity. Success in these projects is often measured by how well they meet key benchmarks—cost, schedule, safety, quality, and environmental performance. Despite widespread adoption of project control frameworks, a significant proportion of projects continue to face schedule and budgetary overruns. For instance, Ernst & Young (2014) reported that 78% of upstream oil and gas projects and 68% of LNG projects experienced delays, indicating a systemic performance gap across the sector.

To address this complex challenge, the present study identifies three principal categories of risk—Financial and Technical Risk, Project Management and Contractual Risk, and Procurement and Regulatory Compliance Risk—as the latent dimensions of the Rcp construct. Unlike traditional classifications that catalogue risks independently, this study reconceptualizes risk groups based on their latent impact on project outcomes and their structural interrelations in oil and gas construction environments.

II.i. Financial and Technical Risks (FR and TR)

This category comprises those risks that directly influence a project's financial stability and technical deliverability. Based on field experiences and the synthesis of industry literature, five indicators were identified.

One critical issue is the difficulty in claiming insurance compensation, which often arises due to complex contract terms, delayed incident reporting, and disputes over liability scope. While Tabassi et al. (2012) attribute this to documentation inadequacies, our findings reveal that the oil and gas sector further complicates such claims due to multi-tiered subcontracting and shared risk ownership models.

Incomplete or faulty design and engineering is another recurring risk. Design-related deficiencies often occur due to insufficient geotechnical investigation, lack of interdisciplinary coordination, or underdeveloped specifications, which trigger scope changes, budget inflation, and rework (Love et al., 2012). In our analysis, these issues are not merely technical lapses but are interpreted as upstream drivers of downstream risks, including delayed procurement and compromised constructability.

Variability in design standards and regulatory compliance across international partnerships introduces alignment challenges, particularly in joint ventures. This not only prolongs decision-making but creates multi-jurisdictional ambiguity, which can delay site handovers and approvals (Ozorhon et al., 2008). In our model, this variability is not treated just as a governance issue, but as a dynamic friction between institutional frameworks and operational deliverables.

Constructability, as originally defined by O'Connor et al. (1987), refers to how well a design integrates with efficient construction practices. This study elevates constructability into a latent risk construct, since its absence has a ripple effect on sequencing, manpower planning, safety compliance, and overall workflow continuity.

Project location risks often underemphasized in generic frameworks are found here to be highly contextual and compound in nature. Poor location choices may introduce unforeseen logistical, environmental, or socio-political constraints (Papadopoulou and Dimopoulos, 2018). From our lens, location inadequacies impact not only operational viability but also influence land acquisition disputes, community resistance, and contractor mobilization.

II.ii. Project Management and Contractual Risks (PMR & CR)

This dimension addresses risks emanating from planning weaknesses, contract ambiguities, and stakeholder interactions. Five indicators emerged from the analysis.

Improper project planning and budgeting continue to be a root cause of cost overruns and inefficiencies. As noted by Zwikael and Smyrk (2012), projects with insufficient front-end loading tend to suffer cascading effects on execution. However, in the oil and gas sector, this is amplified by long supply chains and the need for early-stage environmental and social licensing.

Unrealistically tight schedules imposed by project owners are common in state-owned or politically influenced projects. While Hwang and Lim (2013) highlight that compressed timelines escalate safety risks, our study links them directly to rushed design finalization, reduced contractor engagement, and omitted contingency protocols.

Owner interference, especially in technical decision-making or contractor selection, can derail management authority and strategic execution. Assaf and Al-Hejji (2006) noted its role in scope creep, and our findings further show that such interventions often undermine team accountability and blur contractual lines of command.

Ambiguous contract clauses lead to divergent interpretations and increased legal disputes. As Cheung et al. (2004) emphasized, clarity in contractual documentation is crucial for mega projects. We found that ambiguity often results not from lack of detail, but from unclear risk allocation mechanisms—a critical insight for oil and gas settings where multiple entities operate under a shared-risk model.

Discrepancies between contract assumptions and actual worksite conditions (Chan and Kumaraswamy, 1997) are especially problematic in greenfield or offshore projects. Our evidence suggests that such mismatches can stall site mobilization, trigger compensation claims, and disrupt environmental compliance, making them a latent cost and delay driver.

II.iii. Procurement and Regulatory Compliance Risks (PR & RCR)

This dimension reflects the interface between supply chain reliability and institutional oversight. It includes three validated indicators.

Poor quality of procured materials is not simply a function of vendor behaviour, but a systemic weakness in contractor evaluation and cost-cutting practices. As Love and Edwards (2005) note, substandard inputs can compromise structural integrity and necessitate major rework. In our framework, this risk is conceptualized as both a technical and reputational hazard.

Late delivery of materials, though frequently acknowledged, is analysed here for its cumulative effect: it initiates idle labour, rescheduling of subcontractors, increased overheads, and lowered productivity (Sawhney and Rentala, 2012). Our findings reinforce this, especially in modular fabrication projects with tightly sequenced logistics.

Deficiencies in legal and regulatory frameworks, particularly in emerging economies, generate a climate of procedural ambiguity. While Cheung and Yeung (2006) focused on contractual enforcement, this study identifies deeper institutional vacuums owing to unclear permitting protocols, overlapping authorities, and limited dispute resolution mechanisms that erode stakeholder confidence and expose projects to enforcement delays and policy shifts.

III. Rationale of Rcp scale construction

To achieve successful project completion in oil and gas industry, stakeholders have to understand ubiquitous aspects of the design & engineering, contracts, project management and HSE issues which are the integral parts of the execution of the project and the attitude of the stakeholders (owner, consultant, contractors, vendors, government departments, operation team and shareholders) toward the successful project completion. There are strong reasons to construct an **Rcp** scale. Exploration of the underlying factors of principal risks and the sub-risks of the project towards the total risk latent construct (Rcp) has been well explained towards the construct (e.g., MacKenzie et al.2011).

IV. Methodology

IV.i. Generation and Selection of Items

Drawing from the earlier proposed theoretical framework, a new measurement scale for Attitude toward Advertising Music (Aam) was developed. The process of item generation followed the two-step method recommended by Hinkin (1995). Initially, an in-depth literature review was conducted focusing on three key areas: project-related risks, their impact dimensions, and associated mitigation strategies within construction projects.

Subsequently, expert consultations and discussions with domain researchers were carried out. The expert panel included a diverse group of professionals such as project managers, engineers, supply chain experts, academics, financial analysts, and contract specialists. Insights from both the literature review and expert input led to the identification of a three-dimensional construct of Risk in Construction Projects (Rcp).

To formulate specific items aligned with these three factors and randomize their placement in the questionnaire, a pilot test was conducted to assess the clarity and initial validity of the items. A total of 73 statements were initially created to comprehensively cover all three dimensions. These statements were refined based on feedback from the expert panel and research group. The preliminary version of the questionnaire was shared with 34 companies, including international organizations, to evaluate the comprehensibility and effectiveness of the items among potential respondents. Each expert independently reviewed the item list. Their feedback was incorporated during the purification process, leading to minor modifications and the finalization of 73 validated items for the full-scale study.

IV.ii. Data Collection

The study sample consisted of 350 professionals, including academicians and researchers, with experience levels ranging from entry-level (0 years) to over 15 years. Out of the distributed responses, 301 were deemed valid and used for statistical analysis. Data was collected primarily through an online survey administered via Google Forms. Respondents were invited through multiple communication channels, including email, phone calls, and direct meetings.

Participants were asked to complete a four-page questionnaire comprising 11 primary items and corresponding sub-items. Additionally, demographic details—such as age, gender, organizational affiliation, professional role, and years of experience—were captured. Responses were measured using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), with participants providing ratings based on their perception of risk across the defined constructs.

Table 1: Factor Structure of Rcp

Principal	Sub Risk		EFA
Cronbach's Alpha= *0.710 KMO and Bartlett's test: 0.782* Variance Explained 46.54%			
Financial and Technical Risk	FR15	Difficulty in claiming insurance compensation	0.646
	TR1	Poor and incomplete design and engineering	0.740
	TR2	Variability in Standards and Regulations in Joint Ventures	0.695
	TR3	Constructability	0.589
	TR6	Improper selection of project location	0.729
Project Management and Contractual Risk	Cronbach's Alpha= 0.707 *KMO and Bartlett's test: 0.751* Variance Explained 46.116%		
	PMR1	Improper project planning and budgeting	0.661
	PMR10	Unrealistically Tight Project Schedule Set by Owners	0.689
	PMR11	Owners' improper intervention	0.673
	CR4	Ambiguous conditions of contract	0.686
	CR5	Work conditions differing from contract	0.686
Procurement &Regulatory Compliance Risk	Cronbach's Alpha= 0.565 *KMO and Bartlett's test: 0.597* Variance Explained 53.49%		
	PR2	Poor quality of procured materials	0.644
	PR3	Late delivery of material	0.745
	RCR3	Deficiencies and Gaps in Legal Frameworks	0.797

Overall Cronbach's Alpha 0.856

IV.iii. Item reduction

To ensure the internal consistency of the developed scale, a reliability analysis was conducted using SPSS version 16. Cronbach's alpha was used as the key criterion for item retention. Items showing a corrected item-total correlation below 0.40 were excluded from the final scale, following the guidelines recommended by Hair et al.

(2010). The remaining items were those that not only showed distinctiveness but also demonstrated a strong predictive capability regarding the outcome variables. After careful evaluation, a final set of 13 items was retained for detailed analysis. The internal consistency values for the identified components were as follows: Financial and Technical Risk ($\alpha = 0.710$), Project Management and Contractual Risk ($\alpha = 0.707$), and Procurement & Regulatory Compliance Risk ($\alpha = 0.565$). Overall, the composite three-factor model achieved an acceptable reliability score of $\alpha = 0.856$ (refer to Table 1). Items exhibiting cross-loadings above 0.40 on multiple factors were removed, ensuring each retained item had strong loading on its intended dimension and minimal overlap.

IV.iv. Sample Suitability for Factor Analysis

To determine the appropriateness of the dataset for factor analysis, the Kaiser-Meyer-Olkin (KMO) measure was calculated, yielding values of 0.782, 0.751, and 0.597, respectively. These figures suggest that the sample is adequate for reliable multivariate analysis, as the number of items within each factor can be effectively predicted (Hair et al., 2010). Additionally, Bartlett's Test of Sphericity returned a significant Chi-square value, affirming that the inter-item correlations were sufficient to justify proceeding with factor analysis.

IV.v. Analysis and results

IV.v.a. Factor structure

Exploratory Factor Analysis (EFA) was performed using the principal component extraction method with Promax rotation, acknowledging potential correlations among factors. The scree plot and Eigenvalue criteria supported a three-factor solution, with each factor exceeding an Eigenvalue of 1. The cumulative variance explained by the three components was 53.49%. Among the dimensions, Procurement & Regulatory Compliance Risk accounted for the largest portion of variance.

The Promax-rotated structure matrix (Table 1) confirmed the three-factor solution. Factor loadings ranged from 0.66 to 1.00, demonstrating a strong association with the underlying Rcp construct. These results align with Clark and Watson's (1995) criteria for a higher-order construct, further supported by statistically significant intercorrelations among components.

To justify the three-factor solution, multiple criteria were evaluated during EFA. The scree plot displayed a clear inflection point after the third factor, and only these three factors had eigenvalues greater than 1.0, consistent with the Kaiser criterion. Beyond statistical fit, the retained structure also aligned with conceptual clarity and domain relevance. Each factor captured a distinct dimension of risk identified during the item generation phase: Financial and Technical Risk, Project Management and Contractual Risk, and Procurement & Regulatory Compliance Risk—dimensions that are both operationally meaningful and theoretically grounded in the project risk management literature.

Cross-loading was monitored using a threshold of 0.40. Items with substantial dual loadings or conceptual ambiguity were excluded during the item reduction process. Specifically, all retained items in the final structure demonstrated primary loadings above 0.58 and minimal secondary loadings on unintended factors, confirming factor purity. Moreover, the factor correlation matrix revealed that while the components were interrelated, none of them were redundant, justifying the multidimensional nature of the Rcp construct. This combined conceptual-statistical alignment supports the appropriateness of the tri-dimensional structure over simpler unidimensional alternatives.

IV.v.b. Confirmatory factor analysis

The 13-item Rcp scale was subjected to Confirmatory Factor Analysis (CFA) using maximum likelihood estimation in SPSS AMOS (v26). Each of the three first-order factors was specified to load onto a second-order latent variable representing the overarching Rcp construct. Standardized loadings are shown in Figure 1.

The model demonstrated acceptable fit: $\chi^2 = 171.522$, df = 62, $\chi^2/df = 2.766$, GFI = 0.921, CFI = 0.891, NFI = 0.841, and RMSEA = 0.077. These indices suggest an empirically supported and theoretically coherent model.

IV.v.c. Common method variance control

To address potential common method variance (CMV) arising from self-reported data, several procedural remedies were implemented, including guaranteed anonymity and neutral questionnaire phrasing, as recommended by Podsakoff et al. (2003). Additionally, Harman's single-factor test using EFA revealed that no single factor dominated the variance—one factor accounted for 46.54%, while the total variance explained by the three components was 53.49%. These findings suggest that CMV is not a significant concern in this study.

IV.v.d. Reliability and validity

Composite Reliability (CR) values were used to assess internal consistency. Financial and Technical Risk (CR = 0.714), Project Management and Contractual Risk (CR = 0.706), and Procurement & Regulatory Compliance Risk (CR = 0.572) all demonstrated acceptable reliability. While the third factor's CR was slightly below the 0.70 threshold, its inclusion was justified based on theoretical relevance and empirical contribution.

While the Cronbach's Alpha for the "Procurement & Regulatory Compliance Risk" (PR & RCR) dimension was observed to be 0.565, slightly below the conventional threshold of 0.70, it is important to interpret this in the context of the construct's characteristics and domain-specific implications. First, this dimension consists of only three items, and it is well-documented that Cronbach's Alpha tends to be lower when the number of items is limited (Cortina, 1993; Tavakol & Dennick, 2011). Second, each of the three items demonstrated strong standardized loadings in both EFA and CFA (ranging from 0.644 to 0.797), indicating high convergent validity and meaningful individual contributions to the latent construct.

Moreover, this factor represents a composite of operational and institutional risk exposures that, by nature, exhibit high situational variability across projects. Theoretical justification and expert input during the item generation phase confirm its conceptual importance to the overarching Rcp model. Retaining this factor was deemed essential for preserving the content validity and practical comprehensiveness of the scale. The overall model's composite reliability (α = 0.856) further supports the robustness of the scale in measuring construction project risk perception across multiple domains.

Convergent validity was supported by strong inter-item loadings and inter-factor correlations, confirming that Rcp is a higher-order construct composed of three interrelated but distinct dimensions.

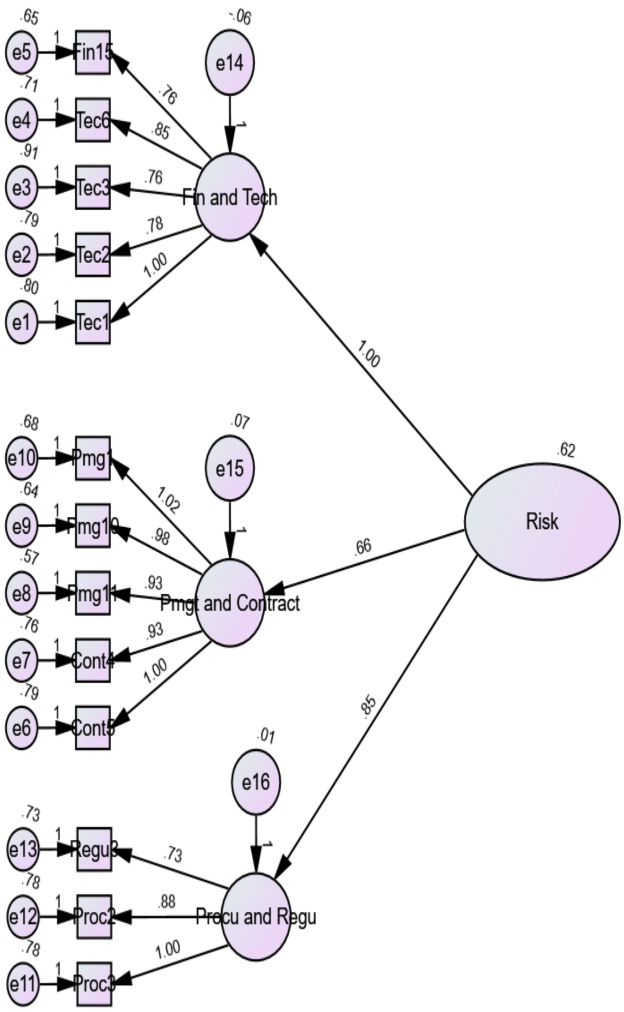

Fig.1. Model 1; CFA Model for R_{cp} (GFI= 0.921, CFI= 0.891, RMSEA= 0.077)

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	29	171.522	62	.000	2.766

IV.v.e. Comparative model analysis

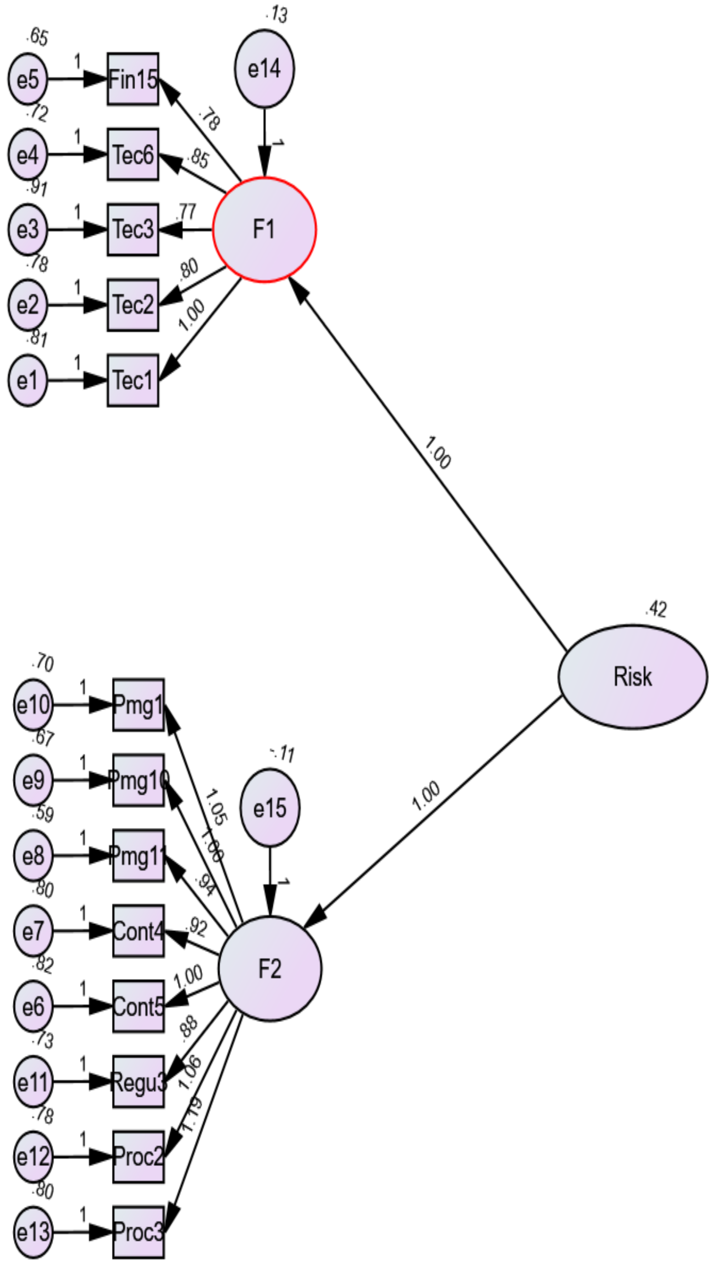

Fig.2. Model 2; CFA Model for R_{cp} (GFI= 0.917, CFI= 0.882, RMSEA = 0.078)

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	27	182.222	64	.000	2.847

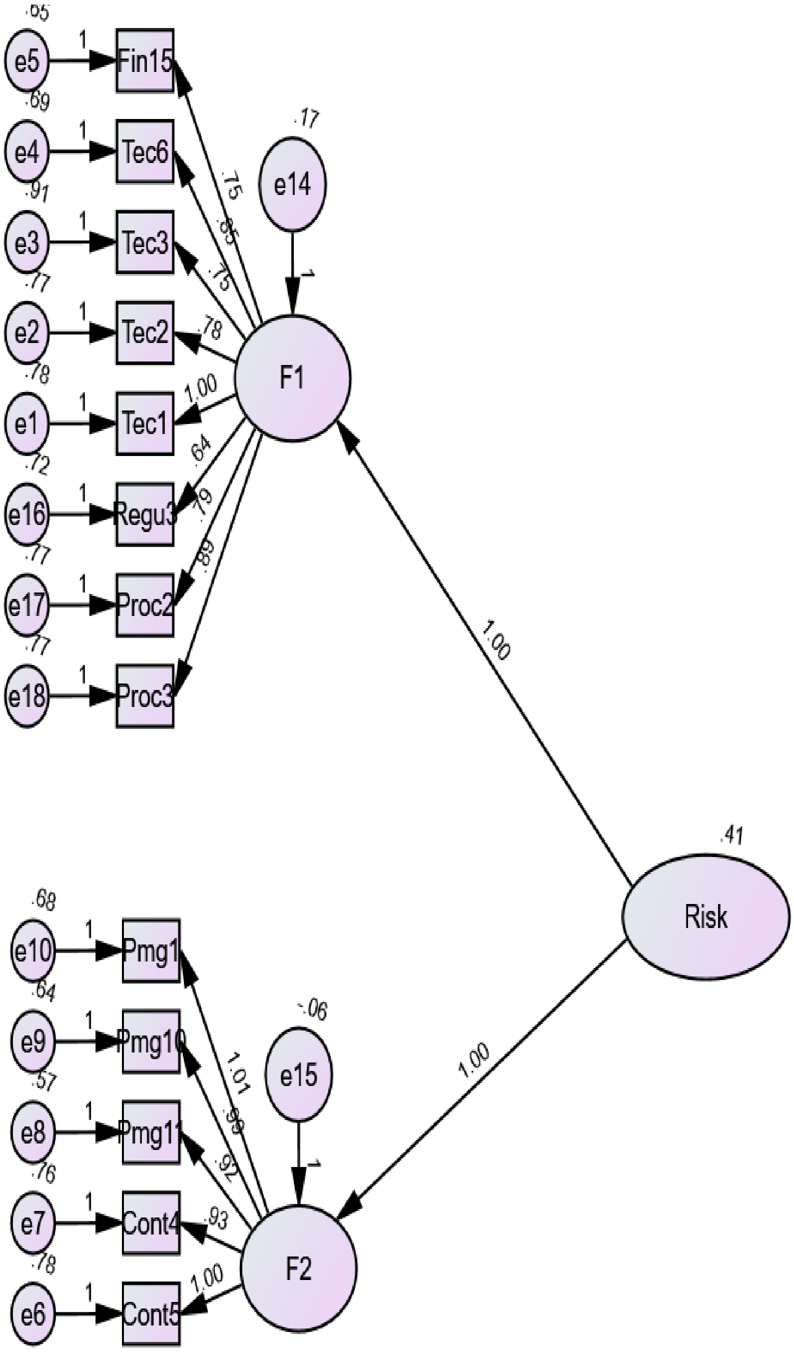

Fig. 3: Model 3; CFA Model for R_{cp} (GFI= 0.92, CFI= 0.89, RMSEA = 0.076)

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	27	174.112	64	.000	2.721

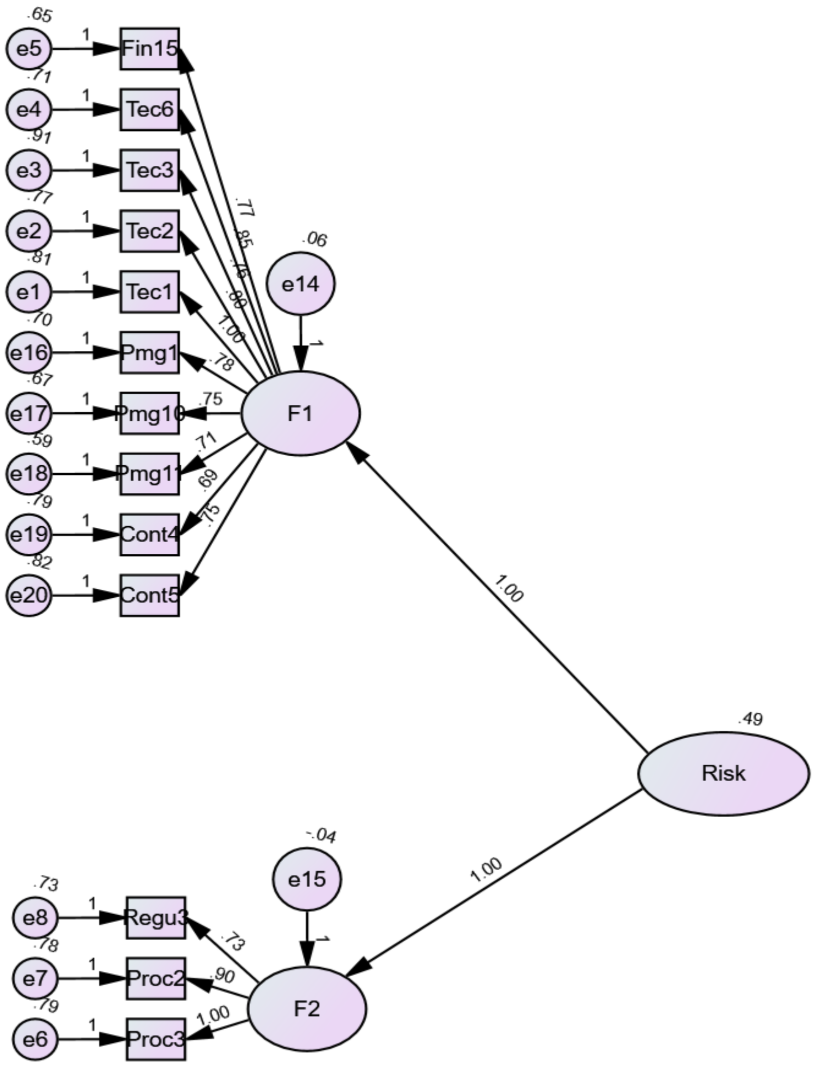

Fig. 4. Model 4;CFA Model for R_{cp} (GFI= 0.917, CFI= 0.882, RMSEA = 0.079)

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	27	182.366	64	.000	2.849

Among the three factors of R_{cp}, discriminant validity could not be achieved by using AVE values. These intercorrelated factors belong to the same higher-order construct, i.e., R_{cp}.

Table 2: Comparative Model Analysis.

Models	Factors	λ^2	df	$\Delta\lambda^2$	RMSEA	GFI
Model 1	3(Financial and Technical Risk; Project Management and Contractual Risk; Procurement &Regulatory Compliance Risk	171.522	62	-	0.077	0.921
Model 2	2{(Project Management and Contractual Risk +Procurement &Regulatory Compliance Risk); Financial and Technical Risk}	182.222	64	10.7	0.078	0.917
Model 3	2{(Financial and Technical Risk + Procurement &Regulatory Compliance Risk); Project Management and Contractual Risk}	174.112	64	8.11	0.076	0.92
Model 4	2 {(Financial and Technical Risk + Project Management and Contractual Risk); Procurement &Regulatory Compliance Risk}	182.366	64	8.254	0.079	0.917

To validate the structural integrity of the Rcp construct, several alternative CFA models were tested by combining different factors into two-component configurations (Figures 2–4). These included: (i) grouping Project Management and Contractual Risk with Procurement & Regulatory Compliance Risk; (ii) grouping Financial and Technical Risk with Procurement Risk; and (iii) grouping Financial and Technical Risk with Project Management and Contractual Risk.

Each model was assessed using standard fit indices. As summarized in Table 2, the original three-factor model (Model 1) consistently outperformed the alternatives, with superior GFI (0.921), CFI (0.891), and RMSEA (0.077). Although discriminant validity could not be fully established using AVE due to high inter-factor correlations, the results affirm that these dimensions collectively represent a coherent and multidimensional Rcp construct.

IV.vi. Summary and discussion

The three-dimensional structure validated in this study was not only statistically sound but also conceptually interpretable, reflecting core domains of construction project risk encountered in the oil and gas sector. This study presents an empirical investigation aimed at identifying and validating three key dimensions of the Rcp (Risk in Construction Projects) construct: *Financial and Technical Risk*, *Project Management and Contractual Risk*, and *Procurement & Regulatory Compliance Risk*. The main objective was to uncover the latent structure of Rcp and provide empirical support through rigorous analysis. Results strongly endorse a three-factor model, which has been confirmed using comprehensive statistical methods. This contribution enhances the conceptual foundation of the Rcp framework by delineating and validating its core components.

Through Exploratory and Confirmatory Factor Analyses (EFA and CFA), a total of 13 reliable items were retained to measure Rcp. Specifically, *Financial and Technical Risk* comprises five indicators, *Project Management and Contractual Risk* includes five, and *Procurement & Regulatory Compliance Risk* also consists of five items. Detailed descriptions of these indicators can be found in Sections 2.1, 2.2, and 2.3 of this paper. The following paragraphs discuss critical insights related to each risk dimension, drawing from both the current findings and supporting literature.

The *Financial and Technical Risk* dimension reflects issues such as delays in insurance settlements, which hinder recovery from unforeseen events. Inadequate or incomplete design and engineering often result in costly modifications, safety concerns, and project delays. Discrepancies in design standards, safety norms, or quality benchmarks can lead to ineffective designs and overlooked site constraints, ultimately raising costs and causing rework. Additionally, suboptimal site selection may introduce logistical limitations, environmental barriers, or resistance from local communities.

The second dimension, *Project Management and Contractual Risk*, emerges as a critical factor with the highest loadings in the model. Challenges such as poor planning, unrealistic timelines imposed by owners, and inappropriate owner involvement can significantly disrupt project delivery. Compressed timelines can lead to compromised safety and quality, while unauthorized interference from clients may destabilize workflows and strategic decision-making. Moreover, ambiguous contractual terms, delays in approvals, and unforeseen worksite conditions not specified in contracts often lead to disputes, additional costs, and project delays.

The third component, *Procurement & Regulatory Compliance Risk*, includes concerns over inadequate legal frameworks that may cause compliance uncertainties, regulatory delays, and legal complications. Procuring substandard materials can impact both structural safety and project lifespan, resulting in rework and budget overruns. Furthermore, delays in material procurement negatively affect the project schedule, create workflow interruptions, and inflate overall costs.

In conclusion, identifying these three core risk areas provides valuable guidance for project stakeholders—including owners, consultants, and contractors—to better anticipate and manage critical risk elements, thereby improving the likelihood of project success in terms of timeline, cost, and quality.

V. Implications

Project stakeholders often exhibit varying perceptions and reactions to the different categories of risks that emerge during construction. In this context, Rcp (Risk in Construction Projects) has been conceptualized as the evaluative stance of stakeholders toward such risks. The study empirically confirms that Rcp encompasses three core dimensions—*Financial & Technical Risk*, *Project Management & Contractual Risk*, and *Procurement & Regulatory Compliance Risk*—each influenced by distinct project-related factors.

The Rcp scale developed in this research is concise, comprising 13 well-defined items, and is designed for ease of administration. Psychometric evaluation affirms its internal consistency, along with satisfactory reliability and validity. This makes the scale a valuable instrument for both academic research and professional practice in project management.

From a practitioner's standpoint, the validated items offer a systematic approach to understanding stakeholder behaviour and perceptions. These insights can guide the formulation of targeted mitigation strategies. Project managers and associated personnel may employ the Rcp scale to monitor and interpret stakeholders' attitudes towards risk, enabling proactive risk response planning. Furthermore, owners, consultants, and contractors can utilize this scale to better engage with teams and foster a more informed and constructive risk management culture—ultimately contributing to the timely, cost-effective, and high-quality execution of projects.

Conflict of Interest:

There was no relevant conflict of interest regarding this paper.

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