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Critical Success Factors for Sustainable Enterprise Risk Management: A Case of the United Arab Emirates Construction Industry

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Abstract

Integrating sustainability principles into enterprise risk management has become a strategic priority for construction organizations seeking resilience and long-term value creation. Despite growing attention to sustainability-driven risk governance, limited empirical research has examined the underlying enablers that determine the successful adoption of Sustainable Enterprise Risk Management (SERM) in the construction context. This study identifies and validates the critical success factors (CSFs) that facilitate effective SERM implementation, focusing on the construction industry of the United Arab Emirates. A multi-method research design was employed, encompassing a systematic literature review to extract potential CSFs, followed by a quantitative phase involving Relative Importance Index (RII) analysis, Exploratory Factor Analysis (EFA), and Partial Least Squares Structural Equation Modeling (PLS-SEM) applied to data from 106 industry professionals and expert interviews. The analysis uncovered 22 CSFs structured into four interdependent dimensions: '*strategic risk governance*', '*risk culture and leadership*', '*regulatory and process integration*', and '*risk infrastructure and communication*'. The findings reveal '*strategic risk governance*', significantly influencing '*risk culture and leadership*', which in turn mediate the development of robust risk infrastructure and communication systems, thereby enabling comprehensive SERM integration. The validated conceptual framework offers practical insights for enhancing resilience, regulatory alignment, and long-term competitiveness in construction organizations. This study advances theoretical discourse by repositioning SERM as a system of interdependent enablers rather than a compliance-driven function and contributes actionable strategies for embedding sustainability into enterprise-wide risk governance.

Keywords: Sustainable Enterprise risk management (SERM); critical success factors (CSF); construction projects; Factor analysis; relative importance index (RII); structure equation modeling (SEM)

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1. Introduction

One of the world's most risk-prone industries is the construction industry [1]. Among the various reasons for this are the industry's critical role in meeting infrastructure needs across all activity sectors; the complex and ever-changing dynamics of construction, resulting in frequent cost overruns, delays, and failures to meet operational and quality standards; the vast network of interrelated actors in the industry; and other stochastic factors beyond human control [2,3]. Traditionally, the focus has been on managing risks at the project level, as individual projects are primary revenue sources [4]. However, this narrow focus can lead to challenges such as a fragmented understanding of risks, limited transparency between projects, suboptimal resource distribution, and obstacles in fulfilling broader corporate strategies [5,6]. Organizations have recently undergone a major transformation in their risk management strategies, shifting toward a more holistic perspective [7,8]. Central to this evolution is enterprise risk management (ERM), which has garnered considerable attention on a global scale [9]. According to the Committee of Sponsoring Organizations of the Treadway Commission [10], ERM is characterized as "*a process, carried out by an organization's board of directors, management, and staff, that is integrated into strategy formulation and across the organization, aimed at identifying potential events that could impact the organization and managing risks in alignment with its risk appetite, thereby providing reasonable assurance for the achievement of organizational objectives*".

ERM is essential for driving sustainable development in the construction industry by identifying, measuring, and managing risks that impact long-term organizational success [11,12]. Effective ERM practices enhance economic efficiency, foster growth, and boost investor confidence [13]. Given the complexity of construction projects, ERM is a crucial factor influencing business performance. However, as globalization, technological advancements, and evolving stakeholder expectations reshape the industry, construction firms must adapt their risk management strategies to remain competitive [14]. While ERM is widely recognized for its role in managing project and operational risks, ensuring its own process is sustainable remains underexplored [15]. Companies implement ERM to improve performance indicators, optimize decision-making, and minimize losses (Liu et al., 2011; Low et al., 2013). However, for ERM to deliver lasting value, it must be integrated into an organization's long-term strategy, continuously improved, and adapted to changing environments. This shift towards Sustainable ERM (SERM) is not about managing sustainability-related risks but rather ensuring that ERM itself remains effective, agile, and resilient over time.

SERM enhances traditional ERM by broadening its scope and introducing a more holistic and forward-looking orientation to risk governance. Unlike conventional ERM, which typically centers on financial and operational risk mitigation, SERM incorporates long-term sustainability considerations, enabling organizations to respond to emerging environmental, social, and governance (ESG) challenges [13]. According to [16], SERM is the process of identifying, assessing, and prioritizing threats to cost-effective organizational performance, while adopting long-term initiatives to address and mitigate these risks. This practice ensures that organizations not only manage immediate risks but also maintain resilience and sustainability over time [17]. It encourages organizations to consider the environmental and social consequences of their actions, promoting responsible practices and minimizing negative externalities [16]. Recent empirical research such as the work of Bashir et al. [18], Dewi et al. [19] and Jegan Joseph Jerome et al. [20] confirms that SERM implementation in construction firms is positively associated with enhanced competitive advantage, improved sustainability performance, and strengthened stakeholder relationships, reinforcing its value as a transformative tool in high-risk project environments.

This relevance is magnified in the construction sector, where the convergence of high-risk project environments and long-term sustainability pressures creates unique operational challenges. In the United Arab Emirates (UAE), the construction industry is a central pillar of economic development, yet it faces persistent exposure to uncertainties ranging from regulatory fluctuations to environmental and social liabilities [21]. Despite a general awareness of risk, many firms continue to apply fragmented approaches that neglect the broader sustainability implications of their activities. Risk management practices in UAE construction projects often lack methodological depth, limiting their capacity to anticipate and mitigate systemic project risks [22]. Integrating SERM in the construction of projects is essential to mitigate these negative impacts and enhance the long-term viability of the industry. The adoption of SERM practices enables construction companies in the UAE to proactively manage risks related to environmental regulations, resource scarcity, and growing social expectations, while also creating opportunities for innovation and improved efficiency [23].

Despite extensive research on ERM across industries manufacturing [24], banking [25], construction [6] and healthcare [26], there is little focus on the critical success factors (CSFs) driving

SERM implementation, particularly in the UAE construction sector. The UAE presents a unique setting due to its rapid urbanization, regulatory developments, and increasing emphasis on structured risk management in construction. Understanding the CSFs of SERM in this context can provide valuable insights into how organizations can strengthen ERM frameworks to support long-term business continuity and industry resilience as highlighted Hristov et al. [27]. This forms the central motivation of the current study, which is positioned to fill this critical gap by identifying the organizational elements that underpin effective and enduring SERM in the UAE's construction environment.

Prior research on risk management in the construction industry has primarily focused on traditional ERM frameworks, risk identification tools, and their influence on operational or financial performance [28–30]. These studies have contributed to a foundational understanding of how construction firms manage risks, yet they tend to concentrate on procedural aspects or firm-level outcomes, often excluding broader sustainability dimensions. More recent work has emphasized the need for integrated approaches that link risk governance with long-term environmental and social goals, yet empirical investigation into such approaches, particularly in project-based contexts, remains limited [16,31]. It has been noted that the CSFs that enable or constrain the effective integration of SERM in construction are underexplored, particularly in the context of emerging economies. This gap has limited the operational relevance of existing ERM models and their ability to support sustainability-aligned project delivery. As a result, there is a need for research that identifies and contextualizes the key enablers of SERM implementation. This study responds to that gap by focusing on the construction industry in the UAE. To this end, this research aims to investigate the CSFs that enable effective SERM integration in the UAE construction industry. The objectives are to: (1) identify the CSFs that matter most to SERM in construction settings; (2) assess the significance of these factors for long-term business continuity and resilience; (3) group the factors into clear dimensions that reflect the main areas of SERM; and (4) explore how these factors collectively contribute to strengthening enterprise-wide risk management frameworks in the context of the UAE construction industry.

1.1. Contributions

This research contribution can be summarized as follows. First, this research identifies and categorizes the critical success factors essential for the effective implementation of SERM in the UAE construction sector. While existing literature has emphasized the importance of identifying CSFs for enterprise risk practices, particularly in sectors with high volatility and complex stakeholder networks [5,32], the integration of sustainability principles into ERM frameworks within the Middle Eastern construction context remains underexplored. This research addresses that gap by focusing on sector-specific characteristics such as rapid urbanization, regulatory evolution, and economic diversification unique to the UAE, thereby contributing new empirical knowledge relevant to both regional and international audiences. This approach aligns with calls for more context-specific analyses in construction project management [33].

Second, the study applies a multi-method approach, including a Systematic Literature Review, Relative Importance Index, Exploratory Factor Analysis, and Structural Equation Modeling, to examine the structure and influence of SERM CSFs. Prior research has validated the use of combined statistical methodologies for risk factor prioritization and model development [34,35]. This comprehensive design enables a layered investigation; first identifying CSFs through literature synthesis, then validating their significance via industry data, and finally testing causal pathways using SEM. This contributes methodologically by refining how empirical models can be used to capture interdependencies in construction risk governance.

Third, the research empirically validates that strategic risk governance acts as a foundational enabler, positively impacting organizational risk culture and leadership, which in turn influence the robustness of risk infrastructure and communication systems. These interlinkages are crucial for facilitating seamless regulatory and process integration within construction firms [36]. The findings support the conceptual alignment with COSO's ERM framework while extending its applicability to sustainable risk practices [10].

Fourth, the study introduces a validated SERM model that supports long-term organizational resilience and competitive advantage in high-risk construction environments. This model advances theoretical discourse by contextualizing sustainability not only as an environmental consideration but as a structural requirement for enterprise-wide risk strategy. It aligns with emerging perspectives that call for resilience and agility in risk management as strategic imperatives rather than operational afterthoughts [37]. The model provides construction organizations with a structured pathway to integrate sustainability into risk governance, helping transition ERM from compliance-oriented to strategy-driven frameworks.

Fifth, the study offers actionable insights for industry professionals and policymakers by outlining how specific organizational capabilities such as governance, leadership, and communication can be leveraged to enhance regulatory integration and operational resilience. This has practical implications for reforming policy and institutional mechanisms in the UAE and comparable economies. These insights are intended to guide future industry initiatives aimed at embedding sustainability within core risk management practices, thereby improving project outcomes and long-term viability.

1.2. Knowledge Gap Identification

Despite growing scholarly attention to risk management for sustainability in construction, the literature reveals persistent gaps. For example, Guan et al. [38] examined interdependencies among risks in green building projects via interpretive structural modeling, but this project-level analysis did not integrate sustainability considerations into a broader ERM framework. Similarly, Qazi et al. [39] introduced a Monte Carlo simulation-based process to prioritize sustainability-related construction risks in the UAE; however, their focus on isolated project risk prioritization fails to bridge into enterprise-wide sustainable risk management. Erdenekhuu et al. [40] proposed a method combining Monte Carlo and AHP to assess critical environmental risk factors in construction activities, yet this approach remains confined to the environmental dimension at the project level and does not model how multiple success factors interrelate within an organization's risk landscape. Likewise, Kassem [36] used PLS-SEM to model key risk factors affecting project success in oil and gas construction, capturing static cause–effect relationships but without addressing sustainability performance or dynamic enterprise contexts. Furthermore, Prakash and Ambekar [6] employed a Delphi-driven ISM–MICMAC framework to map hierarchical ERM barriers in Indian construction firmsemerald.com, yet their barrier-centric analysis omitted sustainability considerations and offered no guidance for enterprise-level SERM integration. Collectively, these studies demonstrate limited integration of ERM and sustainability at the enterprise level. This clear knowledge gap in enterprise wide SERM integration indicates the need for research that synthesizes sustainability and risk management beyond the project scope. The present study fills this gap by adopting a structured, multi-method approach that integrates sustainability into ERM at the enterprise level, models the complex interdependencies among CSFs, and is tailored to the dynamic conditions of the UAE construction industry. Table 1 summarizes the most recent and relevant studies, highlighting their focus, findings, and the specific gaps that the current research seeks to fill.

Table 1. Summary of Existing Studies.

Reference	Region	Focus and Context	Key Findings	Limitations/Gap
[38].	Global	Risk interdependencies in sustainable (green) building projects	Identified critical drivers of risk in green projects and mapped their cascading effects; provides holistic insight	Project-level analysis only; does not address enterprise-wide integration of sustainability into ERM. Highlights that prior

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			into risk-sustainability links at project level.	research on sustainable construction risks was fragmented, lacking an overarching ERM framework.
[39]	UAE	Sustainability-related risk prioritization in construction projects using risk matrix-based Monte Carlo simulation. Focus on capturing "tail" risks in project risk management.	Conventional risk matrices underestimate critical sustainability risks. Demonstrated the importance of advanced risk analytics to inform sustainability goals.	Concentrated on project risk management (sustainability at project scale). Lacks extension to enterprise-level ERM, where multiple projects and strategic sustainability objectives interact.
[40]	South Africa	Environmental risk assessment for sustainable construction operations to evaluate how construction-phase risks impact environmental sustainability	Environmental "hotspots" identified: air, water, and land pollution, etc., were most critical. Showed that certain operational risks significantly worsen environmental outcomes and costs. Underscores need to manage sustainability risks to avoid project underperformance.	Narrow focus on environmental dimension and a single-project case. Does not integrate social or economic sustainability factors. Provides a tool for project risk analysis but not a comprehensive enterprise risk-sustainability strategy.
[36]	Yemen	Enterprise risk factor modeling in construction (oil & gas projects). Investigated how various internal and external risks affect project success.	Developed a validated risk factor model linking risk causes to project performance. Illustrates a structured approach to ERM in construction projects.	Focuses on traditional project success metrics; omits explicit sustainability performance criteria Context-specific to Yemen's oil/gas sector, which calls for extending such ERM models to incorporate sustainability and to dynamic markets (e.g. UAE) with different risk profiles.
[6]	India	Barriers to implementing ERM in construction; employed Delphi plus ISM–MICMAC to hierarchically model relationships among ERM barriers in Indian firms.	Revealed individual-level barriers (low awareness, inadequate training) as root causes; organizational factors (lack of top management commitment) emerged as most dependent. Hierarchy shows how lower-level issues escalate into wider challenges.	Examines ERM barriers without considering sustainability dimensions; region-specific to India; does not extend to sustainable ERM or enterprise-level sustainability integration.

The paper rest of the paper is organized as follows: Section 2 details the research methodology used in the study, while Section 3 presents the results and analysis. Section 4 offers a discussion on the key findings, and Section 5 concludes by summarizing the main insights drawn from the research.

2. Methodology

The study employed a structured mixed-method approach, following a series of clearly defined steps, as shown in Figure 1.

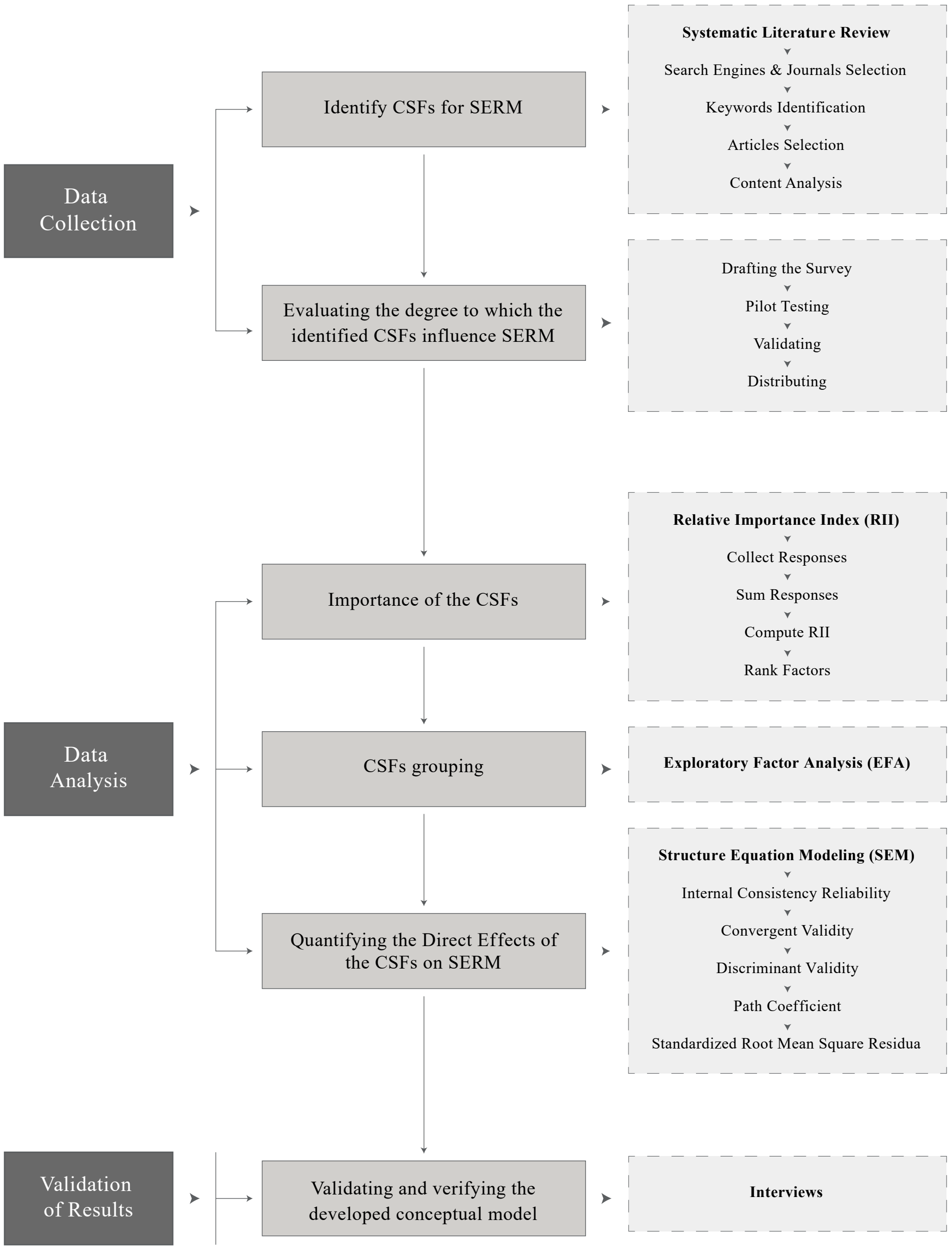

Figure 1. Research Methodology.

2.1. Step 1—Systematic Literature Review to Identify CFSs

To develop a comprehensive definition and set of fundamental pillars for SRM, an SLR was conducted following the PRISMA framework [41], a widely recognized guideline used in multiple review papers. The framework consists of four essential steps: identifying potential literature sources, screening them, verifying their eligibility, and determining whether to include or exclude them. In the identification phase, the review focused on studies from 2014 to 2024, a period marked by a growing emphasis on sustainability in organizational strategies, particularly in the construction sector. While the specific term "sustainable ERM" is still emerging, related research underscores the industry's increasing commitment to sustainable risk management practices [6,39,42]. The adoption of the United Nations Sustainable Development Goals in 2015 accelerated this shift, prompting organizations to incorporate sustainability into their strategies to address environmental concerns and resource efficiency [43]. As a result, sustainability became a key driver of innovation and strategic planning within the industry [44].

A thorough search was completed in Scopus, Taylor & Francis, IEEE Xplore, Emerald Insight, Wiley, and Google Scholar, which were selected for their academic relevance. Journals had to be Scopus-indexed, published in English, and possess an impact factor of at least 2.0. Keywords such as "drivers for ERM," "critical success factors for ERM," and "factors for ERM sustainability in the construction industry" were combined with Boolean operators for precision, and content analysis was used to extract factors influencing SERM implementation [45]. During screening, duplicates were removed, and each record was checked for relevance using its title, publication year, and abstract. PRISMA guidelines were followed, and reasons for exclusion were documented to keep the process transparent. Screening concentrated on papers that directly addressed the research questions, ensuring the selection stayed focused on the study objectives. During eligibility assessment, every remaining study was confirmed against the inclusion criteria. Although PRISMA improves transparency, biases can still appear, including a preference for peer-reviewed journals, the exclusion of non-English studies, and limitations tied to database choice. Subjective judgments in screening and coding were also recognized. To reduce these risks, explicit selection rules were applied, and several reviewers checked each decision independently. The inclusion criteria admitted English-language papers published between 2014 and 2024 that centered on sustainability practices and risk management, whereas studies were excluded if they were not in English, lacked full-text access, or mentioned risk management only superficially.

2.2. Step 2—Survey to Assess CSFs

Following the identification of CSFs, a structured questionnaire survey was administered to assess their perceived influence within the UAE construction sector, a method frequently used in construction management research [2,46]. Prior to data collection, ethical approval was secured from the Institutional Review Board at the American University of Sharjah (AUS) (Protocol #: 25-0190). This method was selected for primary data collection because questionnaire surveys are cost-effective, allow rapid data collection from large, geographically dispersed expert groups, and provide quantifiable insights that have proven reliable in construction research [47,48]

The instrument contained three sections. Section 1 gathered respondent demographics and firm characteristics (job title, years of experience, organization type, typical project size). Section 2 listed the CSFs and asked participants to rate each factor's influence. Section 3 offered an open-ended space for additional comments, enabling qualitative insights. The survey utilized a five-point Likert scale, where 1 represented a very weak influence and 5 indicated a very strong influence, following established research practices [35,36]. Before its official distribution, the questionnaire underwent pilot testing with five experienced UAE construction professionals to refine its structure, improve response options, and eliminate redundant or unclear questions. This process also ensured clarity by identifying and addressing ambiguities or typographical errors [49]. Based on the feedback received, necessary adjustments were made, and pilot responses were excluded from the final dataset to maintain the accuracy of the analysis.

Following pilot testing, a cross-sectional online survey was conducted using non-probabilistic sampling to ensure diverse participation. A total of 150 valid responses were collected from the distributed questionnaires, a sample size consistent with prior construction-sector studies that used similar numbers to ensure adequate representation and reliability in findings [50]. The study employed purposive sampling to select qualified UAE professionals, including main contractors,

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project managers, risk managers, consultants, subcontractors, and academics, and this was followed by snowball sampling, where participants referred additional experts from various backgrounds

The study employed purposive sampling to select qualified UAE professionals, including construction managers, project managers, risk managers, engineers, consultants, and academics. This was followed by snowball sampling, where participants referred additional experts from various backgrounds. To mitigate bias, only individuals with relevant expertise were chosen, referrals were monitored for diversity, and the survey was distributed across multiple platforms, including academic networks and professional forums. To prevent response bias, items were randomized to avoid consecutive similar questions affecting participant answers. The collected data were tabulated, summarized, and analyzed statistically to address the research objectives.

2.3. Step 3—Ranking of CSFs

The responses collected in the previous step were converted into Relative Importance Index (RII) values to rank the CSFs based on their perceived significance. The RII method is widely recognized as a robust and reliable approach for ranking variables based on structured questionnaire responses [51]. It has been extensively applied in construction management research, particularly in studies evaluating risk assessment, project performance, and sustainability integration [51–53]. Those studies highlighted the effectiveness of RII in prioritizing critical factors that influence decision-making in construction projects. The RII was determined using the formula: RII = $\sum$ W/A x N, where W represents the assigned weight for each factor, ranging from 1 (least important) to 5 (most important), N denotes the total number of respondents, $\sum$W is the sum of all responses for a given factor, and A corresponds to the maximum possible weight (5 in this case). The resulting RII values ranged between 0 and 1, with higher values indicating greater significance. The classification of RII values followed the framework proposed by Rajgor et al. [54]: High (H) ($0.8 \leq$ RII ≤ 1), High–Medium (H-M) ($0.6 \leq$ RII ≤ 0.8), Medium (M) ($0.4 \leq$ RII ≤ 0.6), Medium–Low (M-L) ($0.2 \leq$ RII ≤ 0.4), and Low (L) ($0 \leq$ RII ≤ 0.2).

2.4. Step 4—Grouping of Factors into Core Dimensions

After the ranking of the CSFs, Exploratory Factor Analysis (EFA) was employed. EFA is a statistical method designed to consolidate multiple interrelated variables into broader, more fundamental constructs known as “factors” [55]. EFA has been utilized in previous studies on CSFs within construction management [53,56,57] and serves as a precursor to latent variable modeling and Confirmatory Factor Analysis (CFA), which in turn leads to Structural Equation Modeling (SEM). This approach was adopted to uncover the underlying structures among the 22 identified CSFs for SERM. The selection of retainable variables was determined based on factor loadings, with a threshold of ≥0.50, which is widely recognized as an acceptable criterion in construction-related research [36,58].

2.5. Step 5—Evaluation of Interrelationships Among Factors

After factor grouping, a PLS-SEM model was developed to examine how the identified CSFs influence SERM in UAE construction firms. SEM is a widely used technique for examining relationships among variables [1,59,60]. Unlike traditional techniques such as least squares regression, logistic regression, and log-linear modeling, SEM offers several distinct advantages. It enables researchers to evaluate the entire conceptual framework rather than testing individual hypotheses in isolation (Shackman, 2013). Additionally, SEM allows for the estimation of measurement error, enhancing the accuracy of model assessment. There are two primary approaches to SEM: covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM). CB-SEM is particularly well-suited for theory testing, confirmation, and model comparison (Dash and Paul, 2021). This study adopted PLS-SEM due to its capability to handle complex, interdependent relationships, making it particularly suitable for exploratory research and refining existing theoretical frameworks [61]. Given the study’s objective of quantifying the impact of CSFs on SERM, PLS-SEM was employed to (1) assess the reliability and validity of the measurement model and (2) test the hypothesized relationships among key constructs. The data collected during Phase 2 of the research was analyzed using SmartPLS 4, ensuring a rigorous evaluation of the model's structure and the significance of each factor.

2.6. Step 6—Validation Through Expert Interviews

After developing the model, semi-structured interviews were conducted were carried out to validate the model of key CSFs and their interrelationships influencing SERM in UAE construction projects. Semi-structured interviews were chosen for their ability to combine focused inquiry with flexibility, allowing experts to provide detailed insights while ensuring consistency across responses [62]. This approach is widely recommended in construction research for validating complex frameworks due to its depth and practical relevance [63,64]. Six industry experts participated, including two project managers, a construction manager, a consultant, and two academics, all selected for their key decision-making roles or notable academic contributions in the field. Each expert had over a decade of professional experience, ensuring a comprehensive and well-rounded analysis. Their primary role was to assess the conceptual model, validate its findings, and provide insights on strengthening the identified CSFs to enhance the adoption and effectiveness of SERM in the UAE construction sector. The validation process was based on four key criteria: practical relevance, clarity and interpretability, feasibility of implementation, and adaptability to industry changes. Their collective expertise provided diverse perspectives and valuable insights, enriching the study's findings.

3. Analysis and Results

3.1. Identified CSFs for SERM

Using the inclusion criteria outlined in phase 1 of the research methodology, 214 studies related to the CSFs of SERM from 2014 to 2024 were identified. The titles and abstracts of these papers underwent a thorough review to evaluate their relevance and determine their suitability for further examination. A rigorous two-step screening approach was applied to ensure methodological consistency and maintain high research standards. Following an in-depth assessment, only 26 articles were deemed directly relevant to CSFs impacting SERM across various industries. Through this process, a total of 22 key CSFs were identified. To the best of the authors' knowledge, no prior study has comprehensively examined all 22 CSFs simultaneously, particularly in relation to SERM within construction projects. As a result, the findings of this study provide significant contributions to the field. Figure 2 illustrates the SLR outcomes, mapping the identified CSFs to the reviewed literature.

3.2. Descriptive Statistics

Table 1 summarizes respondent demographics, showing a male majority at 75% and females comprising 24%. The educational qualifications indicate a highly skilled sample, with 55% holding a bachelor's degree, 33% earning a postgraduate qualification, and 12% possessing a doctorate. Most participants (77%) are employed in the private sector, and 42% hold managerial positions, reinforcing the study's focus on decision-makers. Industry experience is also notable, with 80% having worked in construction for over a decade, and 58% specializing in multi-purpose projects. In terms of ERM awareness, 53% reported moderate familiarity, while 13% had no prior knowledge, underscoring the relevance of this research. A total of 106 valid responses were collected over ten weeks, aligning with the recommended sample size for SEM-based studies to ensure statistical validity and robust analysis [65,66].

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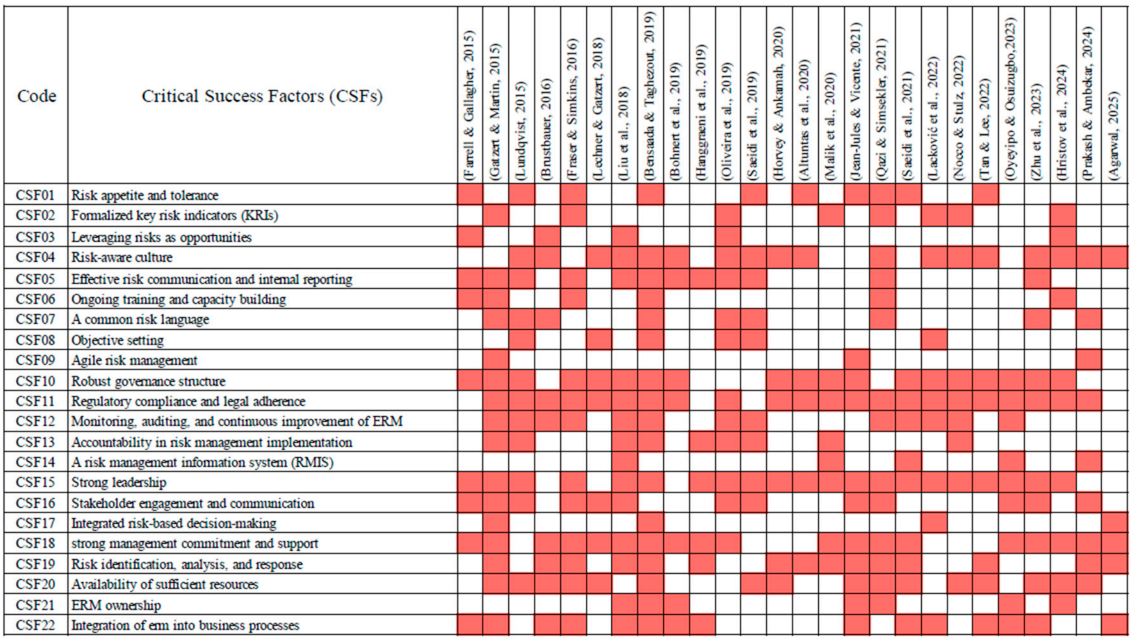

Figure 2. A Mapping Between the Identified CSFs and the Reviewed Literature.

Table 1. Demographic Profile of Respondents.

No.	Demographic Profile	%	No.	Demographic Profile	%
1	Educational level		2	Organization type	
	Bachelor	55		Public Sector	23
	Master's Degree	33		Private Sector	77
	PhD	12			
3	Experience in the construction industry		4	Construction Sector	
	1 - 5 Years	20		Residential	15
	6 - 15 Years	34		Commercial	14
	15 - 25 Years	24		Multi-Purpose	58
	More than 25 Years	22		Infrastructure	13
5	Occupation		6	Familiarity with ERM	
	Project Manager	42		Not Familiar	13
	Contractor	8		Somewhat Familiar	53
	Consultant	19		Very Familiar	33
	Site Engineer	6		Expert	1
	Academic	14			
	Other	11			

3.3. Ranking of the CSFs for SERM

The reliability of the dataset was confirmed by a Cronbach's alpha coefficient of 0.920, surpassing the widely accepted threshold of 0.70 [67], thus demonstrating strong internal consistency. In this study, the 22 CSFs for ERM were ranked using RII, with the computed scores detailed in Table 2. The RII results indicate that all identified CSFs are highly significant, as their values exceed 0.7, reflecting strong consensus among respondents on their critical importance. To determine whether each CSF was significantly relevant to SERM success in the UAE construction sector, a one-sample t-test was performed. The results indicated p-values of 0 for all CSFs, confirming their statistical significance. Furthermore, the Spearman rank correlation coefficient was 0.561, demonstrating a statistically significant agreement at the 0.05 level between the public and private sectors regarding the ranking

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of the 22 CSFs, despite variations in RII scores. The prioritization of these CSFs provides valuable insights for practitioners, enabling them to identify key focus areas for ERM implementation and allocate resources effectively to enhance sustainability in risk management practices.

Table 2. Relative Importance Index (RII) scores of the CSFs.

Code	Factors	RII	Rank	P-value
CSF01	Risk Appetite and Tolerance	0.842	13	0.00
CSF02	Formalized Key Risk Indicators (KRIs)	0.852	12	0.00
CSF03	Leveraging Risks as Opportunities	0.870	8	0.00
CSF04	Risk-Aware Culture	0.855	11	0.00
CSF05	Effective Risk Communication and Internal Reporting	0.894	3	0.00
CSF06	Ongoing Training and Capacity Building	0.896	2	0.00
CSF07	A Common Risk Language	0.836	14	0.00
CSF08	Objective Setting	0.857	10	0.00
CSF09	Agile Risk Management	0.842	13	0.00
CSF10	Robust Governance Structure	0.865	9	0.00
CSF11	Regulatory Compliance and Legal Adherence	0.875	6	0.00
CSF12	Monitoring, Auditing, and Continuous Improvement	0.855	11	0.00
CSF13	Accountability in Risk Management Implementation	0.855	11	0.00
CSF14	A Risk Management Information System (RMIS)	0.831	15	0.00
CSF15	Strong Leadership	0.865	9	0.00
CSF16	Stakeholder Engagement and Communication	0.852	12	0.00
CSF17	Integrated Risk-Based Decision-Making	0.873	7	0.00
CSF18	Strong Management Commitment and Support	0.886	5	0.00
CSF19	Risk Identification, Analysis, and Response	0.875	6	0.00
CSF20	Availability of Sufficient Resources	0.891	4	0.00
CSF21	ERM Ownership	0.894	3	0.00
CSF22	Integration of ERM into Business Processes	0.922	1	0.00

Table 2 highlights a strong overall emphasis on integrating ERM into core business processes, underscoring its critical role in enhancing decision-making, resilience, and long-term value creation. The most highly ranked critical success factor is the integration of erm into business processes, reflecting the industry's recognition that embedding risk practices within operational workflows is vital for sustaining project performance amid growing complexity and regulatory demands. This is followed by ongoing training and capacity building, emphasizing the importance of equipping teams with the skills and awareness needed to adapt to emerging risks and uphold a proactive risk culture. Conversely, risk appetite and tolerance and formalized key risk indicators (KRIs) received the lowest rankings. This is particularly interesting in the UAE context, where organizations, especially in the construction sector, often rely on informal or reactive approaches due to fast-paced project environments and limited regulatory pressure to formalize risk thresholds or metrics. These findings demonstrate that while the specific context may vary, the fundamental pillars of sustainable ERM are consistently viewed as essential for navigating complexity and ensuring organizational continuity.

3.4. CSF Underlying Groupings

In this study, EFA was employed to identify underlying relationships among the 22 CSFs for SERM. The adequacy of factor analysis for extracting factors was evaluated through multiple statistical measures. The Kaiser-Meyer-Olkin (KMO) test resulted in a value of 0.860, demonstrating a strong level of common variance among the CSFs. Additionally, Bartlett's test of sphericity yielded a chi-square value of 2794.054 with a p-value of 0, indicating that the correlation matrix is significantly different from an identity matrix. These findings confirm that EFA is appropriate for identifying the underlying factor structure. The findings, as shown in Table 3, reveal a clear four-factor structure, with each factor consisting of closely related items exhibiting strong loadings. Notably, there are no significant cross-loadings, ensuring that each factor remains distinct. This supports the validity of the four-factor model as an appropriate representation of the data. The factors were named based on the common characteristics shared among the CSFs within each grouping: strategic risk governance, risk culture and leadership, regulatory and process integration, and risk infrastructure and communication.

Table 3. CSFs Groupings Based on EFA Results.

Items	Loadings (F1)	Loadings (F2)	Loadings (F3)	Loadings (F4)
CSF01	0.944	-	-	-
CSF06	0.802	-	-	-
CSF09	0.829	-	-	-
CSF21	0.888	-	-	-
CSF02	0.917	-	-	-
CSF03	-	0.811	-	-
CSF04	-	0.795	-	-
CSF12	-	0.784	-	-
CSF15	-	0.756	-	-
CSF16	-	0.789	-	-
CSF17	-	0.817	-	-
CSF19	-	-	0.846	-
CSF20	-	-	0.845	-
CSF05	-	-	0.821	-
CSF07	-	-	0.747	-
CSF08	-	-	0.842	-
CSF10	-	-	0.819	-
CSF13	-	-	-	0.921
CSF14	-	-	-	0.841
CSF11	-	-	-	0.901
CSF18	-	-	-	0.803
CSF22	-	-	-	0.904

3.4.1. Strategic Risk Governance (SRG)

This establishes the foundation for effective SERM by embedding structured decision-making processes into construction firms. A clearly defined risk appetite and tolerance level enable organizations to balance opportunity and uncertainty, ensuring that risk exposure aligns with strategic goals [68]. Formalized KRIs further enhance this approach by providing measurable benchmarks that allow firms to detect early warning signs and take preemptive action [8]. However, governance structures alone are insufficient without continuous training and capacity building, which equip employees with the necessary skills to identify and manage risks effectively [69]. Agile risk management processes complement this by allowing firms to quickly adapt to shifting market conditions, regulatory changes, and emerging risks, ensuring resilience in an unpredictable environment [70]. Ultimately, establishing clear ERM ownership is crucial in reinforcing accountability and ensuring that risk management is not an isolated function but a core component of corporate strategy [71].

3.4.2. Risk Culture and Leadership (RCL)

A strong risk culture and effective leadership play a critical role in shaping how organizations perceive, manage, and capitalize on risks. Firms that embrace risks as opportunities rather than mere threats gain a competitive edge by fostering innovation and resilience [27]. A well-established risk-aware culture ensures that employees across all levels integrate risk considerations into daily decision-making, reducing the likelihood of unforeseen disruptions [72]. However, sustaining such

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a culture requires continuous monitoring, auditing, and improvement of ERM processes, ensuring that risk management remains dynamic and responsive to industry changes [73]. Strong leadership is the driving force behind this transformation, as executives who actively champion risk-conscious behaviors encourage a mindset where risk is viewed as an integral part of business success [24]. Stakeholder engagement and collaboration further strengthen risk culture by fostering transparency, trust, and shared responsibility for risk mitigation [9]. By embedding risk-based decision-making into corporate structures, firms can align their risk strategies with broader business objectives, ensuring a balance between risk-taking and long-term sustainability [74].

3.4.3. Risk Infrastructure and Communication (RIC)

The effectiveness of risk management heavily relies on the infrastructure and communication mechanisms that support it. Without effective risk communication, even the most sophisticated risk frameworks can fail due to a lack of coordination and awareness [75]. Establishing a common risk language ensures consistency in risk assessments, allowing different departments and stakeholders to interpret and respond to risks uniformly [76]. At the core of this structure lies a strong governance framework that provides clear guidance on risk identification, analysis, and response, ensuring that risk mitigation is systematic rather than reactive [27]. Setting clear objectives further enhances this framework, aligning risk management efforts with broader business goals and enabling firms to measure their risk performance effectively [77]. However, infrastructure alone is insufficient without the allocation of sufficient resources, as underfunded risk management functions often struggle with ineffective monitoring and delayed responses [74].

3.4.4. SERM Integration (SRI)

For risk management to be truly sustainable, it must be embedded within regulatory frameworks and seamlessly integrated into core business processes. Compliance with legal and regulatory requirements forms the foundation of risk accountability, ensuring that firms avoid financial penalties and reputational damage [72]. However, accountability in risk management extends beyond compliance. It requires organizations to instill responsibility across all levels, ensuring that risk ownership is not confined to specialized departments but embraced company-wide [75]. The integration of a Risk Management Information System (RMIS) further strengthens this approach by providing real-time risk insights, enabling organizations to make data-driven decisions and mitigate threats proactively [74]. Yet, even the most advanced risk tools require strong management commitment to be effectively adopted, as leadership plays a key role in ensuring that risk management is not perceived as a regulatory burden but as a strategic necessity [78]. By embedding ERM into business processes, organizations create a resilient structure where risk awareness becomes a natural component of decision-making, ensuring agility, compliance, and long-term sustainability in the fast-evolving construction sector [29].

3.5. Structural Analysis

3.5.1. Hypothesis Development

A conceptual framework was formulated based on the EFA findings to outline the core activities of SERM and the proposed relationships among the four CSF groupings (Figure 3). Recent literature shows that sustainable enterprise-risk success stems from the interplay of governance commitment, cultural alignment, and robust information infrastructure. Strategic risk governance provides the top-down mandate that weaves sustainability objectives into formal risk policies and oversight routines, a link evidenced by public-sector studies reporting stronger sustainability integration when boards adopt active risk-oversight roles [79–81]. Once such direction is in place, a supportive risk culture, nurtured by leaders who model and reward responsible behavior, mobilizes project teams to act on those objectives, as recent work with contractor staff confirms [82]. Digital platforms and structured communication channels then translate intent into practice, supplying timely data that embeds

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sustainability criteria in everyday decisions and demonstrably lifts project-level risk-mitigation performance [83,84]. Transparent communication, in turn, reinforces cultural norms by giving teams shared risk visibility and feedback loops, a dynamic highlighted in contract-management research that links open information flows with proactive, collaborative cultures [85,86]. Finally, governance structures themselves shape culture, as construction firms with explicit sustainability controls report noticeably stronger risk-aware climates, completing the top-down cascade from boardroom to site [87]. Guided by this literature, this framework incorporates five hypotheses:

H1. *Strategic risk governance positively impacts SERM integration within the construction sector.*

H2. *Risk culture and leadership positively impacts SERM integration within the construction sector.*

H3. *Risk infrastructure and communication positively impacts SERM integration within the construction sector.*

H4. *Risk infrastructure and communication positively impacts risk culture and leadership within the construction sector.*

H5. *Strategic risk governance positively impacts risk culture and leadership within the construction sector.*

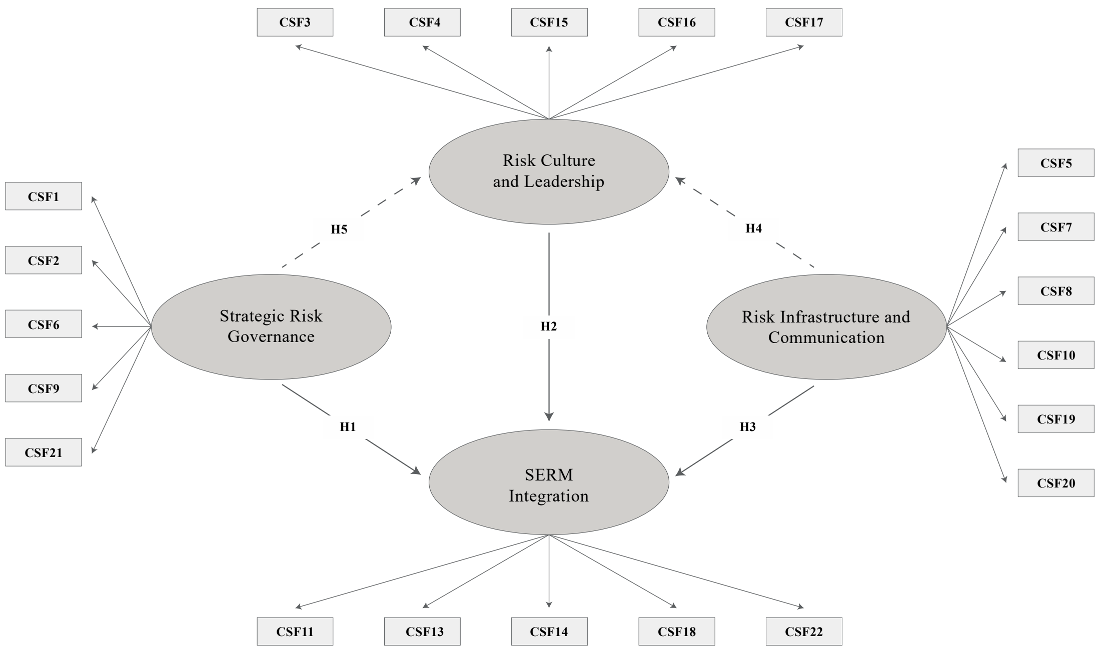

Figure 3. Conceptual Model of the CSFs Influencing SERM.

3.5.2. Evaluation of Measurement Model

The measurement model specifies the relationships between the observed variables and their associated latent constructs [61]. Evaluating this model involves key criteria such as Internal Consistency Reliability, Convergent Validity, and Discriminant Validity [61].

Internal Consistency Reliability: Internal Consistency Reliability ensures that measurements produce stable and consistent results under similar conditions [88]. In PLS-SEM, this reliability is typically assessed using Cronbach's Alpha and Composite Reliability. Cronbach's Alpha measures the correlation between observed indicators [89], while Composite Reliability accounts for varying outer loadings, offering a more precise estimate of reliability [90]. Table 4 presents the reliability values, with Cronbach's Alpha ranging from 0.804 to 0.939 and Composite Reliability between 0.885 and 0.949. As both exceed the recommended 0.70 threshold for construct reliability [67], the measurement model demonstrates strong reliability.

Table 4. Measurement Model Evaluation.

Constructs	Item Code	Factor Loading	Cronbach's Alpha	Composite Reliability	AVE
Strategic risk governance	SRG1	0.917	0.939	0.949	0.804
	SRG2	0.879			
	SRG3	0.896			
	SRG4	0.917			
	SRG5	0.873			
Risk culture and leadership	RCL1	0.812	0.804	0.902	0.673
	RCL2	0.858			
	RCL3	0.766			
	RCL4	0.847			
	RCL5	0.793			
	RCL6	0.844			
SERM integration	SRI1	0.907	0.901	0.938	0.784
	SRI 2	0.857			
	SRI 3	0.896			
	SRI 4	0.876			
	SRI 5	0.891			
Risk infrastructure and communication	RIC1	0.829	0.833	0.885	0.719
	RIC2	0.865			
	RIC3	0.851			
	RIC4	0.814			
	RIC5	0.866			
	RIC6	0.861			

Convergent Validity: Convergent validity determines how well multiple indicators designed to measure the same construct align with one another [91]. In PLS-SEM, this is evaluated using indicator outer loadings and Average Variance Extracted (AVE) [61]. Strong outer loadings signify a robust relationship between the construct and its indicators, reinforcing the accuracy of its representation [66].The factor loadings between 0.766 and 0.917, surpassing the 0.60 reliability threshold [92], which reflects the variance captured by a construct relative to measurement error, ranges from 0.673 to 0.804, exceeding the 0.5 benchmark [91].

Discriminant Validity: Discriminant validity ensures constructs are distinct [93] and is assessed in PLS-SEM using the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT). The Fornell-Larcker method confirms discriminant validity if a construct's AVE square root is greater than its correlations with other constructs [94]. Table 5 confirms that all constructs meet the required conditions for discriminant validity. The HTMT criterion assesses correlations between indicators of different constructs to ensure distinctiveness. Discriminant validity is achieved when HTMT values remain below 0.90 [94]. As shown in Table 6, all constructs in this study satisfy this requirement.

Table 5. Discriminant Validity by HTMT Correlations.

	RPI	RCL	RIC	SRG
RPI				
RCL	0.307			
RIC	0.347	0.306		
SRG	0.388	0.212	0.337	

Table 6. Discriminant Validity by Fornell-Larcker Criterion.

	RPI	RCL	RIC	SRG
RPI	0.886			
RCL	0.290	0.821		
RIC	0.327	0.296	0.848	
SRG	0.369	0.209	0.318	0.897

3.5.3. Evaluation of Structural Model

After verifying the validity and reliability of the construct measurements, the structural model was analyzed to assess internal relationships among dependent variables, their predictive power, and the overall framework's interconnections. This study employed statistical measures such as cross-validated redundancy (Q^2), path coefficients (β), Standardized Root Mean Square Residual (SRMR), and the coefficient of determination (R^2) to ensure model robustness. These measures collectively determine how well the data supports the proposed research model [95]. The following subsections elaborate on each of these assessment criteria.

Coefficient of Determination: The coefficient of determination (R^2) evaluates how well the model predicts outcomes by showing the extent to which changes in the dependent variable are explained by the independent variables [95,96]. In this study, R^2 values were calculated using the bootstrap procedure in SmartPLS 4.0, employing the standard 300 iterations. As shown in the Table 7, the R^2 values for the impact of SRG and RIC on RCL, as well as the effect of SRG, RCL, and RIC on the outcome variable SRI, are 0.102 and 0.213, respectively, which surpasses the threshold of 0.1 recommended by [97], demonstrating an adequate level of predictive accuracy.

Table 7. Structural Model's Coefficient of Determination Values.

Construct Relation	*R2*
Effect of SRG and RIC on RCL	0.102
Effect of SRG, RCL, and RIC on SRI	0.213

Cross-Validated Redundancy: Cross-validated redundancy helps evaluate the relationship between predictor variables in regression and multivariate analysis, reducing the risk of overfitting (Al-Emran et al., 2019). It is a widely accepted resampling approach used to evaluate a model's predictive capability and prevent overfitting. In this study, Q^2 values were derived using the blindfolding technique in SmartPLS 4.0, following 300 iterations, and setting the omission distance to seven. As shown in the Table 8, the Q^2 value for the effect of SRG, RCL, and RIC on SRI is 0.157, and 0.061 for the effects of SRG on RCL and RIC on RCL, exceeding the minimum threshold of 0.00, thereby confirming the model's predictive relevance [95].

Table 8. Structural Model's Cross-validated Redundancy Values.

Endogenous Variable	SSO	SSE	Q^2 (= 1 – SSE/SSO)
Effect of SRG and RIC on RCL	618.000	862.869	0.061
Effect of SRG, RCL, and RIC on SRI	765.000	645.134	0.157

Path Coefficients: The path coefficient (β) is a standardized linear regression weight in SEM, used to evaluate relationships between constructs [61]. A hypothesis is supported when the T-value greater than 1.96 and the p-value is below 0.05 [61].

In this study, all hypotheses were supported, as shown in Table 9. A higher path coefficient indicates a stronger influence of an independent variable on the dependent variable (Al-Emran et al., 2019). H1 examines whether SRG has a positive impact on SRI. Results indicated that SRG had a significant impact on SRI ($\beta = 0.572$, $t = 4.640$, $p < 1\%$). Hence, H1 was supported. Additionally, H2 assesses whether RCL have a positive impact on SRI. Results revealed that RCL had a significant positive impact on SRI (β = 0.478, t = 4.108, p < 1%). Consequently, H2 was supported. H3 evaluates whether RIC positively impact SRI. Results showed that RIC had a significant positive impact on RPI (β = 0.418, t = 4.150, p < 1%). Thus, H3 was supported. H4 evaluates whether RIC have a positive impact on RCL. Results revealed that RIC had a significant impact on RCL (β = 0.355, t = 4.902, p < 1%). Accordingly, H4 was supported. Finally, H5 assesses whether SRG has a positive impact on RCL. Results showed that SRG had a significant impact on RCL (β = 0.388, T = 3.439, p < 1%). Therefore, H5 was supported.

Considering the strength between exogenous (i.e., SRG, RCL, and RIC) and endogenous latent constructs (i.e., SRI and RCL), which is measured by beta coefficient (β) values [98], SRG had the strongest total effects on SRI (β = 0.572), followed by RCL (β = 0.478), and RIC (β = 0.418), respectively.

Table 9. Path Coefficients.

Hypothesis	Path	B value	T statistics (|O/STDEV|)	P value	Decision
H1	SRG -> SRI	0.572	4.640	0.008	Supported
H2	RCL -> SRI	0.478	4.108	0.005	Supported
H3	RIC -> SRI	0.418	4.150	0.002	Supported
H4	RIC -> RCL	0.355	4.902	0.004	Supported
H5	SRG -> RCL	0.388	3.439	0.008	Supported

Mediation Analysis: To assess the mediation role of RCL, the total, direct, and indirect effects of the mediator were calculated as presented in Table 10. The total effect refers to the sum of direct and indirect effects, which can be used to examine the influences of mediating variables on latent variables [99]. The mediator hypotheses evaluate whether RCL mediate the relationship between SRG, RIC, and SRI.

Table 10. Mediation Analysis.

Hypothesis	Total Effects			Direct Effects			Hypothesis	Indirect Effects		
	B	T-value	P value	B	T-value	P value		B	T-value	P value
SRG -> SRI	0.494	2.924	0.003	0.272	3.640	0.008	SRG -> RCL -> SRI	0.223	2.993	0.011
RCL -> SRI	0.378	2.108	0.005	0.178	2.108	0.005	RIC -> RCL -> SRI	0.245	3.684	0.002
RIC -> SRI	0.234	2.629	0.009	0.118	2.150	0.002				

Considering the strength between exogenous (i.e., SRG and RIC) and endogenous latent constructs (i.e., SRI), which is measured by beta coefficient (β) values [98], SRG had the strongest direct effect on SRI (β = 0.494, T = 2.924, P < 1%), followed by RCL (β = 0.378, T = 2.108, P < 1%) and RIC (β = 0.234, T = 2.629, P < 5%). Moreover, the analysis showed that the indirect effects were found to be statistically significant when the mediator was included. The indirect effect of SRG on SRI, mediated by RCL was (β = 0.223, T = 2.993, P < 1%). Similarly, the indirect effect of RIC on SRI, mediated by RCL, was (β = 0.245, T = 3.684, P < 1%). Thus, the influence of SRG and RIC on SRI is fully mediated through RCL, indicating full mediation. Accordingly, hypotheses H3 and H4 are supported.

Standardized Root Mean Square Residual: The model's goodness of fit and potential misspecifications were evaluated using the SRMR [94]. According to [100], an SRMR value below 0.10 signifies an acceptable model fit. In this study, the SRMR was calculated at 0.058, confirming that the model achieves a satisfactory fit.

3.6. Verification of the Developed Model

To ensure the accuracy and reliability of the findings, this study included validation interviews with six independent experts from the UAE construction sector (Table 11). These professionals had no prior involvement in data collection or model development, ensuring an objective evaluation. The experts agreed that the model effectively captured the most critical CSFs necessary for implementing

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SERM, emphasizing its strong alignment with real-world industry needs. They found the framework clear and easy to interpret, making it accessible for decision-makers across different levels. Regarding feasibility, they confirmed that the CSFs could be integrated into existing risk management structures without major challenges. Lastly, the experts highlighted the model's adaptability, noting that it could remain effective as the industry evolves, particularly with emerging risks, regulatory changes, and advancements in risk management practices.

Table 11. Experts' Profile.

Expert	Experience	Job Title	Education		
			BSc	MSc	PhD
1	10–15 years	Project Manager	X		
2	10–15 years	Construction Engineer		X	
3	>20 years	Professor			X
4	10–15 years	Project Manager	X		
5	>20 years	Professor			X
6	>20 years	Construction Consultant	X		

4. Discussion

This research investigates the CSFs that drive the effective implementation of SERM in the UAE construction sector. Through an in-depth analysis, the study explores how these factors facilitate the integration of robust risk management practices. The discussion is reinforced by empirical findings from the PLS-SEM analysis, providing meaningful insights into the key elements shaping SERM adoption within the industry.

4.1. Strategic Risk Governance Impacts on SERM Integration

The analysis revealed that strategic risk governance has a positive impact on SERM integration by establishing a structured framework that aligns organizational processes with regulatory standards. This alignment ensures that compliance is seamlessly embedded within strategic planning, fostering a proactive approach to risk management and regulatory adherence. For instance, a handful of studies note that as the risk management process is integrated into the organization, communication between the entity and the board becomes efficient and meaningful, facilitating better regulatory compliance and process integration [79–81]. Moreover, strategic governance aligns compliance initiatives with broader organizational objectives, preventing regulatory requirements from becoming obstacles to business growth [101]. This alignment fosters a culture of compliance and operational excellence, positioning organizations to navigate the complexities of the construction industry effectively. The following statement captures the perspective of a project manager within the construction sector:

> *"In the UAE, strategic risk governance ensures that companies align their operations with strict regulations and streamline processes to avoid legal and financial penalties. Take the Dubai Metro expansion, for example. It required extensive risk governance to meet safety, environmental, and financial regulations. The implementation of clear policies, digital monitoring systems, and structured risk oversight kept the project compliant and on schedule. Also, the UAE mandates Building Information Modeling (BIM) for large projects, and companies with weak risk governance often fail to integrate BIM properly, leading to compliance issues. On the other hand, firms with structured governance frameworks ensure that regulatory updates are seamlessly incorporated into their processes, reducing project delays and costly rework."*

This perspective is reinforced by recent research demonstrating that organizations utilizing structured digital governance frameworks such as BIM-based compliance automation experience improved coordination with regulatory authorities and significantly fewer procedural lapses

[84,102]. These tools help embed compliance directly into project workflows, enhancing both regulatory alignment and operational efficiency.

4.2. Risk Culture and Leadership Impacts on SERM Integration

The results of this study demonstrate that a strong risk culture, bolstered by effective leadership, significantly enhances SERM integration within the construction industry. This finding is corroborated by existing literature emphasizing the pivotal role of leadership and organizational culture in embedding risk management practices into core business processes [29,68,103]. These studies underscore that leadership commitment to risk management is essential for aligning organizational processes with regulatory requirements, thereby ensuring compliance and operational efficiency. Process integration is also enhanced when risk culture aligns with regulatory expectations. Several studies found that construction firms that emphasize risk-aware leadership integrate regulatory requirements into their project management processes more efficiently, reducing delays and minimizing compliance risks [5,86,104]. The following statement reflects the perspective of one of the experts interviewed for this study:

> *"Strong risk culture and leadership directly impact how well organizations integrate regulations and streamline processes here in the UAE. A real example is the Expo 2020 Dubai site development. With strict sustainability, safety, and labor laws, leadership played a crucial role in ensuring compliance. A proactive risk culture enabled the implementation of real-time risk monitoring, mandatory safety training, and transparent communication, ensuring seamless regulatory integration."*

This expert view reflects recent empirical findings highlighting how leadership and risk culture serve as enablers for regulatory and process integration. Studies show that when leadership fosters a proactive risk environment, organizations are more likely to adopt systems that ensure real-time compliance and transparent communication, which are essential for managing complex regulatory demands in large-scale construction projects [105,106].

4.3. Risk Infrastructure and Communication Impacts on SERM Integration

Robust risk infrastructure and effective communication are pivotal in ensuring seamless SERM integration within the construction industry. In a sector where regulatory landscapes are continually evolving, having a structured risk management framework allows organizations to adapt swiftly and efficiently [5]. For example, the integration of advanced technologies, such as Building Information Modeling (BIM) and Geographic Information Systems (GIS), has been shown to enhance regulatory adherence and streamline processes [107]. This integration not only ensures compliance with existing regulations but also positions organizations to proactively address future regulatory changes, thereby maintaining a competitive edge in the market. The following statement reflects the perspective of one of the experts interviewed for this study:

> *"That's spot on. If a company has weak risk systems, poor reporting tools, unclear communication, or outdated risk assessment methods then compliance becomes a mess, leading to fines or delays. Digital transformation now is improving risk management through AI and automation, but without solid infrastructure, firms struggle with regulations. Effective risk communication ensures compliance updates and safety protocols are understood, making regulatory integration smoother and reducing costly errors".*

Recent empirical studies corroborate this view, showing that BIM-enabled compliance platforms can halve regulatory review times while digital reporting channels, backed by clear communication protocols, reduce compliance breaches significantly [83,84].

4.4. Risk Infrastructure and Communication Impacts on Risk Culture and Leadership

The study findings reveal that a robust risk culture, supported by dedicated leadership, positively influences the development of risk infrastructure and communication channels in the construction sector. When leaders exemplify a steadfast commitment to risk management, it sets a

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precedent, fostering an organizational culture where risk considerations are seamlessly integrated into daily operations. This cultural shift encourages open dialogues about potential risks, promoting transparency and collaborative problem-solving [29]. Several studies highlight that leadership commitment is crucial for the successful implementation of risk management frameworks, as it ensures that risk-related information flows efficiently across all organizational levels [27,28,108]. Such an environment not only enhances the organization's ability to anticipate and mitigate potential challenges but also streamlines responses, thereby maintaining operational continuity. In an industry as intricate and multifaceted as construction, the synergy between a robust risk culture and proactive leadership is essential. It ensures that risk infrastructure is not merely a procedural formality, but a dynamic system supported by effective communication, enabling organizations to navigate complexities with agility and confidence. As one interviewee, an expert in the construction industry, highlighted in the following quote:

"In the UAE construction sector, risk culture and leadership are the backbone of how risk management is actually implemented. You can have all the policies in the world, but if leadership doesn't actively promote risk awareness and accountability, the infrastructure, like reporting systems, training programs, and communication channels, either won't exist or won't be used properly".

Another expert, a CEO in the UAE construction industry, also stated:

"Right now, the UAE is seeing a major shift toward digital construction management, with platforms like BIM, AI-driven risk assessment tools, and real-time project monitoring. But these systems only work if there's a strong risk culture where employees feel responsible for identifying and addressing risks. If leadership fosters that culture, teams are more likely to engage with risk infrastructure documenting issues properly, using communication channels effectively, and making data-driven decisions"

This dual perspective mirrors recent empirical evidence, which shows that leadership-driven risk culture is directly linked to higher uptake of digital risk platforms and clearer information flows in construction firms [85,86], thereby confirming that strong leadership and culture jointly underpin effective risk infrastructure and communication.

4.5. Strategic Risk Governance Impacts on Risk Culture and Leadership

Finally, the results of this study indicate that strategic risk governance serves as the foundation for cultivating a robust risk culture and effective leadership within construction organizations. This finding aligns with existing literature, which emphasizes the critical role of integrating risk management into an organization's strategic planning [28,76,77]. Integrating risk management into the core strategic framework allows companies to demonstrate a top-down commitment to risk awareness and proactive management. This alignment ensures that risk considerations are central to decision-making processes. Tircovnicu & Hategan [79] highlights that embedding risk management processes into organizational strategies leads to more effective communication between the entity and its board, thereby strengthening leadership commitment to risk initiatives. When organizations prioritize strategic risk governance, they position themselves to transform potential challenges into opportunities for growth and innovation, ensuring long-term sustainability and resilience in an ever-evolving industry landscape. The following statement reflects the perspective of one of the experts interviewed for this study:

"The construction here is a high-stakes, fast-moving industry with tight deadlines, massive investments, and strict regulations. If there's no solid strategic risk governance—clear policies, frameworks, and accountability—then risk culture just doesn't develop. People won't take risk management seriously, and leadership won't prioritize it. But when governance is strong, it sets the tone. Leadership buys in, risk awareness spreads, and teams start making better decisions proactively instead of just reacting to crises".

This expert view is echoed in recent studies that confirm the positive relationship between strong governance structures and the development of a proactive risk culture in construction firms [5,109].

5. Conclusions

This study identified the CSFs for SERM in the UAE construction sector and examined their interrelationships. It extended beyond traditional sustainability perspectives by emphasizing the development of ERM systems that remain resilient and adaptable throughout the project lifecycle. The SLR identified 26 relevant studies, leading to the selection of 22 CSFs. These factors were assessed through a structured questionnaire survey of 106 professionals and key stakeholders in the UAE construction industry. The RII analysis showed that all CSFs ranked highly in both the public and private sectors, with the top-ranked factors representing the most crucial elements for successful SERM implementation. EFA grouped these CSFs into four key categories: strategic risk governance, risk culture and leadership, regulatory and process integration, and risk infrastructure and communication. These categories and their interconnections formed a conceptual framework outlining the core areas of SERM in the UAE construction industry. The PLS-SEM analysis confirmed the acceptance of all hypotheses, while expert validation through interviews further reinforced the framework’s relevance. This proposed framework offers a structured understanding of SERM activities and their interrelationships within the UAE construction industry, providing a clearer approach to effective risk management in the sector.

5.1. Theoretical Implications

The outcomes of this study offer both theoretical and practical value. Theoretically, by systematically identifying and categorizing the CSFs that influence SERM implementation, this research enriches existing literature and provides a nuanced understanding of how sustainability considerations integrate with traditional risk management frameworks. This study contributes to theory by emphasizing the internal sustainability of ERM processes themselves, shifting the focus from managing external sustainability risks to sustaining the functionality, relevance, and adaptability of ERM frameworks over time. By clarifying the role of governance, leadership, infrastructure, communication, and regulatory alignment in sustaining ERM, the research provides a basis for future theoretical models that treat SERM as a system of interdependent organizational enablers rather than a compliance function. This reframing invites further scholarly investigation into how these enablers interact under different regulatory and institutional conditions, especially in emerging economies like the UAE. This enhanced perspective lays a robust foundation for future studies, encouraging scholars to delve deeper into SERM dynamics across various sectors. Such exploration is pivotal for developing more resilient and adaptive risk management systems globally.

5.2. Practical Implications

For practitioners, the insights from this study serve as a strategic guide for construction firms in the UAE and potentially in other regions. Pinpointing and analyzing the CSFs helps top management recognize the essential components that facilitate successful SERM adoption. This awareness enables the allocation of necessary resources and fosters executive commitment. The findings can support leadership in reinforcing a proactive risk culture, ensuring that sustainability becomes embedded in decision-making, communication structures, and governance processes. They also help organizations assess the strength of their internal risk environment and identify where adjustments are needed such as improving cross-departmental communication or aligning leadership with regulatory expectations. While the study is contextualized within the UAE, its findings offer a valuable benchmark for construction companies worldwide aiming to embed sustainability into their risk management practices, thereby bolstering industry-wide resilience.

5.3. Future work

Future research could benefit from incorporating project-based case studies alongside expert interviews and surveys to provide a more comprehensive understanding of the CSFs influencing the successful implementation of SERM. Expanding the assessment model to include additional constructs and performance indicators may further refine its applicability. Longitudinal studies could offer valuable insights into how organizations strengthen key CSFs over time and assess the effectiveness of mitigation strategies in dynamic environments. Developing and validating advanced quantitative models that incorporate emerging analytical techniques, such as machine learning, could enhance risk prediction and management capabilities. Testing the proposed model across different geographical regions would help evaluate its generalizability and robustness. Finally, investigating the role of advanced digital technologies in optimizing key CSFs could offer innovative solutions for advancing SERM practices.

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