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Evaluating Enterprise Risk Management in Iran's Cement Industry

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ABSTRACT

Objective: Enterprise Risk Management (ERM) has become the predominant strategic-management approach in modern organizations. Implementing ERM through a risk-vision strategy enhances organizational performance by promoting a forward-looking perspective. This approach requires ongoing monitoring of environmental changes that present both threats and opportunities, allowing firms to respond effectively. Central to this foresight is ERM's ability to identify shifts in markets and the broader business environment. This study seeks to develop and articulate an ERM evaluation model for subsidiaries of selected Iranian cement-holding companies

Methodology: An exploratory mixed-methods design was employed. Grounded Theory was used to inductively construct an ERM evaluation model, resulting in 26 sub-categories grouped into six core categories: causal conditions, the focal phenomenon, contextual conditions, intervening conditions, ERM evaluation strategies, and ERM evaluation consequences.

Results: The Grey DEMATEL method was then applied to analyze the relationships among the model's dimensions. Findings indicate that causal conditions influence the focal phenomenon, which in turn shapes evaluation strategies for ERM. These strategies directly affect the outcomes of ERM evaluation. Additionally, both contextual and intervening conditions impact ERM strategies, while intervening conditions also affect causal conditions.

Conclusion: This study enhances understanding of the relationships within the Risk Management Evaluation Framework and offers practical management strategies for holding companies in the Iranian cement industry.

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Introduction

Effective risk management is strongly associated with enhanced corporate profitability and financial resilience (Stulz, 2024). Risk hedging—the strategic transfer of risk—can generate added corporate value while reducing bankruptcy probability (Nocco et al., 2022). Theoretically, a well-established positive relationship exists between corporate risk management and firm performance (Farooq et al., 2025). Holistic risk management enables organizations to absorb higher risk levels, benefit from diversification, and address inefficiencies arising from the fragmentation of risk distribution across business units or regions. Additionally, it reduces hedging costs by eliminating redundant coverage and focusing on residual risk (González et al., 2020). As a crucial tool for mitigating vulnerabilities (Rehman, 2024), risk management enables firms to achieve their objectives while minimizing the impact of volatility (Settembre-Blundo et al., 2021).

Conglomerate holdings exemplify organizations where opportunity capitalization drives risk-related initiatives (Altuntas et al., 2021). Supporting this, Malik et al. (2020) demonstrated the significant positive effect of ERM on corporate performance through 260 firm-year observations from London Stock Exchange companies (2012-2015), noting that dedicated risk committees further strengthen this relationship.

Recent ERM research confirms the applicability of comprehensive frameworks across diverse industries (Ahmad Jaber & Mohammed Shah, 2024; Crawford & Jabbour, 2024), including financial institutions where frameworks encompass risk identification, analysis, and evaluation (Adam et al., 2023). Similar optimization principles apply to the deployment of technological infrastructure, where heuristic algorithms effectively address NP-hard problems, such as roadside unit coverage under budget constraints (Mohaghar et al., 2023). Key identified risks span political competition, human capital, market dynamics, liquidity, regulatory compliance, and credit exposure (Biresaw & Sibindi, 2025; Jalilvand & Moorthy, 2023; Hong, 2023). This highlights the necessity of adapting management frameworks to specific contexts, which aligns with findings in competitiveness research that show macroeconomic environments significantly influence technological readiness (Jafarnejad et al., 2013).

The transferability of ERM frameworks to industrial sectors warrants increased scholarly attention (Monazzam & Crawford, 2024). Industrial environments, particularly in emerging markets, necessitate tailored risk management approaches due to their unique operational challenges (Jean-Jules & Vicente, 2021). Scenario-based strategic planning, as demonstrated in technology roadmap development for complex supply chains, provides a robust methodology for anticipating and mitigating future risks (Karimi et al., 2022). This is especially relevant in the cement manufacturing sector, where sector-specific risks, such as supply chain vulnerabilities,

environmental compliance pressures, and workforce competency gaps, critically impact operational sustainability (Asgari & Abdipour, 2025; Asadi Touranlou et al., 2025).

The Iranian cement industry presents a compelling case for ERM adaptation (Jafari et al., 2023). Middle Eastern cement producers, including Iranian subsidiaries, face heightened regulatory and operational risks due to regional economic volatility and stringent environmental policies (Fadel et al., 2024). This complexity necessitates specialized ERM models incorporating both universal risk principles and local industrial particularities, aligning with emerging market risk management research (Melhim & Isaifan, 2025; Mishra et al., 2025).

Historically, corporate risk management has been fragmented, with "pure" hazards managed in isolated silos while treasury departments hedge financial exposures separately (McShane et al., 2011). ERM addresses this by conceptualizing risk management as an integrated process covering all threat types to corporate objectives (Arena et al., 2011). Farrell and Gallagher (2015) demonstrated a value-creation premium for firms with mature ERM systems, showing a 25% increase in firm value for those achieving the highest maturity scores. The most substantial valuation effects correlated with continuous performance management, process management, firm-wide ERM adoption, root-cause analysis, and effective risk responses. Notably, fewer than half of the surveyed firms reached upper maturity tiers (levels 4 and 5).

Iran ranks among major global cement producers, yet domestic firms operate under diverse holding structures: five subsidiaries under Cement Industry Investment & Development Holding (CIDH), twelve under Fars & Khuzestan Cement, six under Tehran Cement, six under Cement-Tamin Investment, three under Espandar Cement Investment, and four under Ghadir Cement Holding (Dawoudian et al., 2021; Khorshidikia et al., 2025). Despite facing multifaceted risks across commercial, production, human resources, environmental, and financial domains, no unified risk-management framework exists. Current practices typically address only financial and environmental risks (Xie et al., 2025).

For instance, CIDH maintains eleven specialized committees (Synergy, Human Resources, Investment, Legal, Evaluation, Centralized Purchasing, Receivables, Finance, Localization, Audit, and Appointments) (Burjaliani et al., 2025), yet risk issues remain siloed. Subsidiaries show similar patterns—organizational charts lack dedicated risk-management units or Chief Risk Officers. Other holdings exhibit a similar structure, lacking standalone risk committees at the holding level or dedicated subsidiary units (Haelterman et al., 2022; Sithipolvanichgul et al., 2025).

This study, therefore, develops a suitable ERM evaluation model for cement-holding subsidiaries through a qualitative, data-driven methodology incorporating managerial experience

and industry expertise. Implementation promises reduced uncertainty and more reliable production and delivery systems. The research addresses two fundamental questions:

1. What are the key dimensions and components of the Enterprise Risk Management Evaluation (ERME) model for cement holding company subsidiaries?

2. What cause-and-effect relationships exist between core dimensions constituting the ERME model for these subsidiaries?

Literature Background

Risk Management

Risk management is broadly defined as a structured process for identifying potential events that may impact an organization's sustainability and for managing those risks to provide reasonable assurance regarding the achievement of organizational objectives (Bazaluk et al., 2024). Historically, risk management has been fragmented into organizational "silos," as firms typically structure activities along functional lines to facilitate decision-making. Enterprise Risk Management (ERM) emerged specifically to overcome the limitations of this siloed approach by addressing risks comprehensively across the entire exposure portfolio (Haelterman, 2022; González et al., 2020).

Financial institutions play a crucial role in sustaining and enhancing economic growth, making risk management within these organizations particularly significant for both their performance and the broader economic system (Saeidi et al., 2019). In Iran's competitive financial landscape, institutions that effectively control and manage risks gain a distinct competitive advantage. The fundamental stages of risk management encompass identification, evaluation, mitigation, and monitoring (Dellana et al., 2022).

ERM

ERM has become the dominant strategic-management approach within organizations. Implementing ERM through a risk-vision strategy positively affects organizational performance by fostering a forward-looking stance. A risk vision requires vigilant monitoring of environmental shifts that generate threats and opportunities, enabling timely and appropriate responses. The linchpin of adequate risk foresight is ERM's capacity to gauge changes in markets and the broader environment (Mahama et al., 2022). Consistent with Saeidi et al. (2019), ERM is positively related to firms' competitive advantage.

Crucially, an ERM system is not a one-size-fits-all solution: what works in one organization may not be transferable to another. Each ERM architecture is unique, and its success is firm-specific—it cannot simply be purchased "off the shelf." Consequently, ERM confers benefits to the organization that implements and internalizes it, advantages that rival firms cannot readily appropriate.

Subsidiaries within holding companies, due to the diverse investment decisions they face, rarely operate under conditions of complete certainty; instead, they confront multiple risks in an environment of pervasive uncertainty (Boliari & Topyan, 2022; Liu, 2021). Given that holdings primarily focus on investing in—and overseeing the performance of—their subsidiaries, risk management within those subsidiaries is critical; it effectively safeguards the parent company's invested capital (Khanipour et al., 2022). ERM thus serves as a framework through which a firm, in any industry, controls, exploits, and monitors risks from every conceivable angle, to maximize both short-term and long-term value for stakeholders (Saeidi et al., 2019). Many studies have been conducted on the topic of risk management. Below is a review of some of the key research in this area (Table 1).

The following table synthesizes key findings from recent research on ERM, highlighting its diverse impacts on firm value, performance, and strategic outcomes across various contexts and industries.

Table 1. Empirical Background of the Research

Summary of Findings	The Subject/Objective of the Research	Authors (Year)
Corporate Social Responsibility (CSR) enhances firm value, and this relationship is mediated by ERM and moderated by Corporate Governance (CG).	The role of ERM and corporate governance in the relationship between CSR and firm value.	Farooq et al. (2025)
Companies emphasize internal control in ERM execution. Board IT governance weakens the impact of digital transformation on risk management, with non-state-owned firms driving digital transformation more effectively for performance.	The impact of digital transformation on firm performance, considering the roles of ERM and corporate governance.	Xu et al. (2024)
Organizational risk management has a positive impact on strategic agility and business model innovation in uncertain environments. Strategic agility fosters business model	The role of organizational risk management and strategic agility in driving business model innovation.	Wirahadi and Pasaribu (2022)

Summary of Findings	The Subject/Objective of the Research	Authors (Year)
innovation, which, in turn, enhances financial performance.		
The adoption of organizational risk management by insurers led to a reduction in debt payment levels, potentially increasing their financial vulnerability to unexpected shocks.	The Relationship between Organizational Risk Management and Debt Payment in European Union Insurers.	Nguyen and Vo (2020)
Significant differences exist between American and Slovak companies regarding their risk management approaches and the subsequent effects on business performance.	A cross-cultural comparison of organizational risk management approaches and their relationship with business performance.	Klučka and Grünbichler (2020)
Risk management approaches have a significant impact on the survival rates of Small and Medium Enterprises (SMEs).	The Relationship between Risk Management Approaches and the Survival of SMEs in Nigeria.	Ade et al. (2020)
A theoretical framework for ERM implementation must integrate both social factors (e.g., structure, roles) and technical factors (e.g., systems, policies, laws).	A review of the implementation of organizational risk management as a social and technical challenge.	Jean-Jules and Vicente (2020)
The adoption of organizational risk management is associated with a higher company value, as measured by Tobin's Q (approx. 5.46% increase).	The Impact of Organizational Risk Management on the Firm Value of Non-Financial Companies in Romania.	Anton and Nucu (2020)
The adoption of organizational risk management is not associated with changes in company performance (ROE, ROA, Tobin's Q) nor with a reduction in bankruptcy risk.	The impact of organizational risk management on the risk and performance of listed companies in Spain.	González et al. (2020)
Key ERM components (internal environment, goal setting, control activities, and monitoring) are positive and significant predictors of firm performance.	The relationship between implementing organizational risk management and firm performance in the oil and gas industry.	Shad and Lai (2019)
Increased implementation of the ERM framework leads to improved performance in extractive companies.	The Impact of Corporate Risk Management on Institutional Performance in Jordanian Public Joint-Stock Companies.	Altanashat et al. (2019)

Summary and Results	The subject/objective of the research	Authors (year)
Findings indicated that corporate risk management has a positive relationship with company performance, and intellectual capital has a moderating effect on financial performance.	The Impact of Corporate Risk Management on Firm Performance with the Moderating Effect of Intellectual Capital Dimensions	Saeidi et al. (2019)
The study revealed that family-owned companies tend to exhibit less acceptance of corporate risk management, particularly in those with a family CEO.	Corporate Risk Management in Family-Owned Companies: Evidence from Austria and Germany	Hiebl et al. (2019)
All companies studied implemented corporate risk management systems, considering the high exposure to risks in the fuel and energy industries.	Efficiency of Organizational Risk Management Systems: A Comparative Analysis in the Fuel and Energy Sectors Based on Companies Listed on the Warsaw Stock Exchange	Jonek-Kowalska (2019)
This study demonstrates that a supportive internal environment for corporate risk management, goal alignment with risk, and event identification have a positive impact on firm performance; however, none of these effects were statistically significant.	The Impact of Organizational Risk Management on Firm Performance: Evidence from the Diversified Industry in Sri Lanka	Alawattegama (2018)
The results showed that corporate risk management, asset return rate, and firm size have a significant positive impact on firm value. In contrast, managerial ownership has a significant adverse effect on firm value.	The Impact of Organizational Risk Management on Firm Value in Manufacturing Companies Listed on the Indonesia Stock Exchange (2010-2013)	Iswajuni et al. (2018)
The results showed that the adoption of corporate risk management significantly reduces the company's capital cost.	Organizational Risk Management and Capital Cost	Berry-Stölzle and Xu (2018)
Analysis shows that the implementation of corporate risk management varies across industries, with a corporate risk management framework being more prevalent in the infrastructure, hospitality, and technology sectors.	Organizational Risk Management Practices among Malaysian Companies	Soltanizadeh et al. (2014)

Despite the substantial body of research on risk management, few studies have focused on developing a dedicated ERM evaluation model for subsidiaries of cement industry holdings. To date, no framework has been identified that simultaneously delineates the causal, contextual, and

intervening conditions, as well as the strategies and consequences, of risk-management practices in these subsidiaries. Accordingly, the present study aims to develop an evaluation model for ERM in companies affiliated with Iran's cement sector holdings.

Despite the substantial body of research on risk management, few studies have focused on developing a dedicated model for evaluating ERM within the subsidiaries of cement industry holdings. A review of the existing literature reveals an absence of a comprehensive framework that simultaneously delineates the causal conditions, contextual and intervening conditions, strategies, and consequences of risk-management practices specific to these subsidiaries. To address this gap, the present study aims to develop a comprehensive evaluation model for ERM, tailored explicitly to companies affiliated with Iran's cement sector holdings.

Materials and Methods

This study adopts a fundamental research approach, utilizing a mixed-methods exploratory sequential design framed within a single cross-sectional survey. The research unfolds in two distinct phases.

In the initial qualitative phase, data were collected through semi-structured interviews conducted with industry experts, including managers from subsidiaries of selected Iranian cement holding companies and other specialists in risk management. A snowball sampling technique was employed, culminating in 13 completed interviews. The data from this phase were analyzed using Grounded Theory, following the systematic approach outlined by Strauss and Corbin, to develop a model that elucidates the risk management evaluation process.

Subsequently, the quantitative phase sought to examine the interrelationships among the constructs identified in the ERM evaluation model. This was achieved using the Grey DEMATEL method. The target population for this phase consisted of managers and experts from the same cement subsidiaries. Given constraints of time and access to qualified experts, snowball sampling was again utilized, with questionnaires distributed to 10 individuals. Of these, 6 provided valid and complete responses suitable for analysis.

To ensure the robustness of the research, several measures were implemented to enhance validity and reliability. Internal validity was strengthened through methodological triangulation, member checking, reflexivity to mitigate researcher bias, and peer review of the findings. Furthermore, the reliability of the qualitative coding process was quantitatively assessed. An analysis of 100 codes generated independently by the researcher and a research assistant revealed 38 overlapping codes, resulting in an inter-coder reliability rate of 76%. This figure surpasses the

accepted threshold of 60%, thereby confirming the consistency and dependability of the coding procedure.

This structured, sequential methodological approach ensures a rigorous process for data collection, analysis, and validation, significantly enhancing the credibility and trustworthiness of the study's findings.

Data Collection and Framework Development

The foundation of this study rests on a systematic literature review conducted to identify and synthesize key dimensions of ERME. The literature search was performed across major academic databases, including Scopus and Web of Science, using a combination of keywords such as "enterprise risk management," "enterprise risk management evaluation," "performance measurement," and "framework development." The search was limited to peer-reviewed articles published in English between 2000 and 2023. Initially, a total of 357 articles were identified. After applying inclusion criteria—focusing on studies that proposed or validated ERM frameworks—and excluding duplicates and irrelevant publications, 68 articles were selected for in-depth analysis. Thematic analysis was then employed to extract and categorize critical factors, which were subsequently organized into the core dimensions of our proposed paradigm model: Causal Conditions, Contextual Conditions, Intervening Conditions, Strategies, and Outcomes. This structured approach ensures the framework is comprehensively grounded in established literature.

Results

Grounded Theory Results

The core findings of this study are derived from a Grounded Theory analysis of primary data collected through semi-structured interviews. The data source comprised 13 in-depth interviews with managers and technical specialists operating within the Iranian cement sector, all of whom were employed by subsidiaries of selected cement holdings.

The study's subsidiary research questions guided the analytical process. The author conducted a meticulous, line-by-line examination of the interview transcripts. Each meaningful segment of data was assigned a descriptive label, generating the initial open codes as prescribed by the Grounded Theory methodology.

From this systematic coding process, a core category emerged: risk-management triggers. This category represents the constellation of conditions, events, and internal or external pressures that prompt subsidiaries to initiate a formal ERM evaluation process. These triggers serve as the

fundamental motivational forces, providing the underlying rationale for why the subsidiaries within the selected cement holdings engage in structured risk management activities.

Table 2. Causal Conditions of the ERME

Core category	Sub-categories	Open codes
Causal Conditions for ERM Evaluation	Risk-management culture	Management and staff commitment to ERM
		Emphasis on workforce health in the cement industry
		Organizational culture supportive of risk management
		Formal ERM strategies are in place
	Legal and organizational mandates	National policy and banking system requirements
		Existence of international laws and obligations
		Concern for the firm's public image
	Economic and social pressures	Imperatives of a "resistance economy"
		Compliance costs arising from standards and regulations
		Exchange-rate volatility
	Intra-organizational drivers within cement holdings	Fulfillment of holding-company objectives
		Upgrading of process technologies
		Protection of stakeholders' interests in cement holdings
		Organizational resilience
	Risk landscape of cement holdings	Hierarchical (structural) risk
		Control risks
		Strategic risks
		Risks from unsuitable appointments
		Disaster-recovery cost risk
		Knowledge risks
		Market-loss risk

Table 3. Elements of attention to the Central Phenomenon of ERME

Core category	Sub-categories	Open codes
Attention to the ERM-Evaluation Phenomenon	Emphasis on correctly identifying existing risks	Managerial support for risk management initiatives.
		Accurate understanding of risk concepts
		Strategic awareness of risk among decision-makers
	Emphasis on assessing the identified risks	Unified approach to organizational risks.
		Clear roles and delegated authority in risk management
		Full implementation of risk processes
		Effective risk prioritization
	Emphasis on the effectiveness of risk evaluation	Recognition of cross-team contributions to risk.
		Positive employee attitude toward risk.
		Sense of usefulness and motivation in risk tasks

The category “Attention to the ERM Evaluation phenomenon in companies” comprises three sub-categories encompassing ten specific indicators. Intervening conditions are broad, overarching circumstances that either facilitate or constrain action/reaction strategies. These conditions vary from one company to another.

Table 4. Contextual conditions for ERME

Core category	Sub-categories	Open codes
Contextual Conditions for Risk Management Evaluation	Complexity of the Cement Industry	International sanctions are currently imposed on the industry
		Stability of foreign policy
		Varying maturity levels of organizations active in the industry
		Various cumbersome regulations
	National Infrastructure	Availability of hardware and software facilities
		Presence of suitable transportation routes
		Modern communication networks and information systems
	Cement Industry Environment	Economic boom or recession
		Government economic policies, sovereign policies, and the banking system
		Culture supporting risk management in the industry

The category of contextual conditions for risk management evaluation encompasses three subcategories and ten underlying open codes.

Table 5. Intervening Conditions Affecting ERME

Core category	Sub-categories	Open codes
Intervening conditions in ERM evaluation	Employee competencies in the cement industry	Employees' understanding of ERM concepts
		Relative ability to identify and gauge risks
		Decision-makers' awareness of risk management
		Capacity to provide timely, appropriate support during incidents
	Organisational climate within cement holdings	Managers' information hoarding and censorship
		Inefficient audit/assessment controls
		Inadequate appraisal systems
		Diving into detail without sufficient knowledge
		Lack of consensus among subsidiaries
	Structural characteristics of the cement sector	Misalignment of organisational structures across the holding
		Large scale of the holding
		Expansionist tendency toward acquisition and growth
	Industry agility and flexibility	Excessive bureaucracy
		Weak adaptability
		Decision-making delays
	Managerial obstacles in active subsidiaries	Frequent managerial turnover
		Inappropriate appointments
		Failure to delegate authority
		Political interference influences managerial decisions
	Enabling (or constraining) organisational factors	Strategic scenario planning
		Top-management commitment and support
		Skilled, educated, knowledge-based workforce
		Resistance to risk identification and assessment

Six key sub-categories, defined by twenty-three open codes, constitute the intervening factors that moderate the risk management evaluation process in companies.

Table 6. ERME Strategies

Core category	Sub-categories	Open codes
Strategies for Evaluating Enterprise Risk Management	Enhancing corporate capabilities	Empowering strategic stakeholders
		Strengthening focal domains
		Planning and development activities
		Institutionalising ERM approaches
		Assessing and refining ERM processes
	Disseminating a risk-management culture across the industry	Spreading foundational ERM concepts among industry actors
		Industry-wide risk-culture building
		Advancing ERM maturity levels in cement-sector firms
	Risk avoidance	Replacing high-risk processes with risk-free alternatives
		Avoiding the use of hazardous equipment and tools
		Refraining from investing in high-risk domains
		Declining contracts with high-risk clients
	Diversification	Selecting a diversified investment portfolio
		Contracting with a variety of suppliers
		Engaging a diverse customer base
	Risk transfer	Structuring supplier agreements to include indemnification clauses
		Inserting unilateral termination clauses in contracts with high-risk customers
		Incorporating compensation provisions in customer contracts

Five strategic subcategories, defined by eighteen open codes, form the category of risk management evaluation strategies.

Table 7. Elements of ERME Outcomes

Core category	Sub-categories	Open codes
Enterprise Risk Management Evaluation Outcomes	Improved societal well-being	Greater authority and standing for the cement industry
		Enhanced macro-economic conditions
		Fewer social challenges
		Higher safety and health standards
	Organisational continuity	Strengthened organisational survival
		Deployment of a comprehensive ERM system
		Risk reduction
		Rapid disaster recovery
		Prevention of financial and non-financial losses
		Reduced production downtime
		Alignment of individual and corporate objectives
	Organisational growth	Value creation for stakeholders
		Increased work effectiveness
		More responsible employee behaviour
		Smoother work processes
	Profitability	Creation of competitive advantage
		Protection of all partners' interests
		Productivity gains

The Risk Management Evaluation Outcomes category comprises four subcategories, substantiated by eighteen open codes. The resulting grounded theory is visualized in Figure 1, which presents the "Paradigm Model for Assessing Risk Management in Subsidiaries of Selected Iranian Cement Holdings.

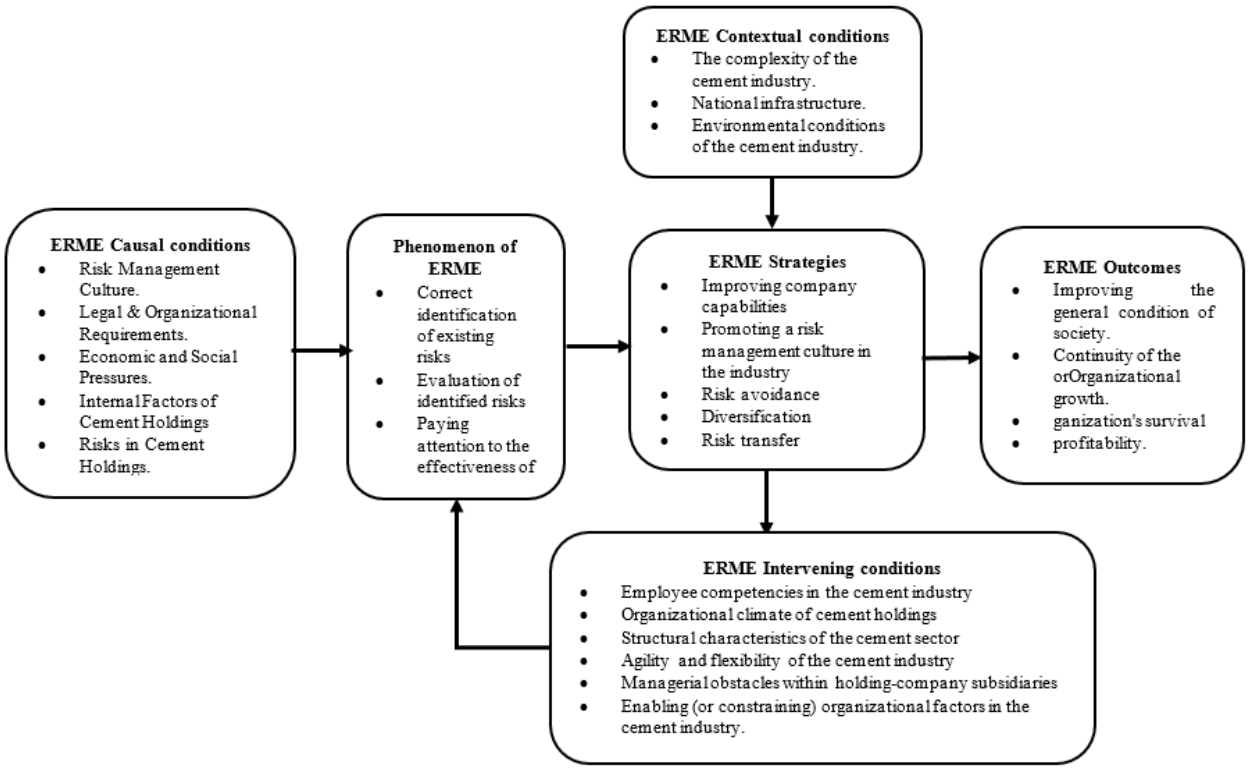

Figure 1. Paradigm model ERME of selected Iranian cement holdings

Grey DEMATEL Results

The Grey DEMATEL analysis was conducted to elucidate the interrelationships among the core categories of the risk management evaluation model. A dedicated DEMATEL questionnaire was distributed to a panel of six experts. The panel comprised senior managers from subsidiary companies of selected Iranian cement holdings, all of whom possessed a minimum of five years of experience, held a master's degree or higher, and were thoroughly familiar with risk management concepts. The analysis proceeded in a structured sequence. Initially, the six core categories derived from the paradigmatic model were designated as the factors for the DEMATEL matrix. These categories are: Causal conditions of risk management evaluation, Contextual conditions of risk management evaluation, Intervening conditions of risk management evaluation, Risk management evaluation strategies, Outcomes of risk management evaluation, and the core phenomenon (focus) of risk management evaluation.

These six categories formed the row and column dimensions of the initial direct relation matrix. The expert panel was then instructed to evaluate the direct influence of each factor on every other

factor using the provided questionnaire. To systematically capture the experts' judgments, a predefined linguistic scale was employed, converting qualitative assessments into Grey numbers. Under the assumption of equal expertise among the evaluators, their individual judgments were aggregated into a single, consolidated Grey direct-relation matrix. This final aggregated matrix, which serves as the foundation for all subsequent calculations, is presented in Table 8.

Table 8. Final Z Matrix

Z	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Causal conditions of ERME	0.000	0.337	0.226	0.142	0.210	0.863
Contextual conditions of ERME	0.367	0.000	0.219	0.750	0.246	0.246
Intervening conditions of ERME	0.775	0.323	0.000	0.850	0.315	0.204
Strategies for ERME	0.213	0.285	0.153	0.000	0.775	0.260
outcomes of ERME	0.215	0.340	0.545	0.242	0.000	0.306
Attention to the ERME phenomenon	0.200	0.194	0.229	0.850	0.142	0.000

The total aggregated decision matrix was then normalized to produce the normalized direct-relation matrix, as shown in Table 9.

Table 9. Normalized matrix of direct relationships

N	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Causal conditions of ERME	0.000	0.119	0.080	0.050	0.074	0.304
Contextual conditions of ERME	0.129	0.000	0.077	0.265	0.087	0.087
Intervening conditions of ERME	0.274	0.114	0.000	0.300	0.111	0.072
Strategies for ERME	0.075	0.100	0.054	0.000	0.274	0.092
outcomes of ERME	0.076	0.120	0.192	0.085	0.000	0.108
Attention to the ERME phenomenon	0.071	0.069	0.081	0.300	0.050	0.000

Subsequently, the total relation matrix was computed based on the normalized direct-relation matrix. The complete total relation matrix is presented in Table 10.

Table 10. total relation matrix

T	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Causal conditions of ERME	0.171	0.261	0.218	0.351	0.252	0.454
Contextual conditions of ERME	0.291	0.165	0.220	0.500	0.298	0.284
Intervening conditions of ERME	0.468	0.323	0.196	0.606	0.379	0.353
Strategies for ERME	0.233	0.246	0.207	0.255	0.418	0.268
outcomes of ERME	0.258	0.266	0.313	0.365	0.191	0.286
Attention to the ERME phenomenon	0.223	0.212	0.205	0.503	0.254	0.175

Based on the total relation matrix, the causal relationships and interaction degrees among factors have been determined. The horizontal sum vector (Ri) and vertical sum vector (Dj) were calculated as follows:

- R_i represents the total influence (direct and indirect) exerted by factor i on all other factors.

- D_j indicates the total influence received by factor j from all other factors.

Additionally, two key parameters were derived:

- P_i ($R_i + D_j$) reflects the overall importance of factor i within the system.

- E_i ($R_i - D_j$) represents the net effect of factor i. A positive E_i value indicates that the factor is a net cause, influencing others more than it is influenced, while a negative E_i value identifies it as a net effect, being more influenced by other factors. These values —R_i, D_j, P_i, and E_i—are summarized in Table 11.

Table 11. Grey DEMATEL final Results

Core category	R_i	D_j	P_i	E_i
Causal conditions of ERME	1.706	1.644	3.350	0.062
Contextual conditions of ERME	1.758	1.472	3.230	0.286
Intervening conditions of ERME	2.326	1.360	3.686	0.966
Strategies for ERME	1.628	2.579	4.207	-0.950
Outcomes of ERME	1.678	1.793	3.471	-0.115
Attention to the ERME Phenomenon	1.572	1.820	3.392	-0.249

The values of (Pi) (overall importance) and (Ei) (net effect) for each factor are visualized in a two-dimensional coordinate system, as illustrated in Figure 2.

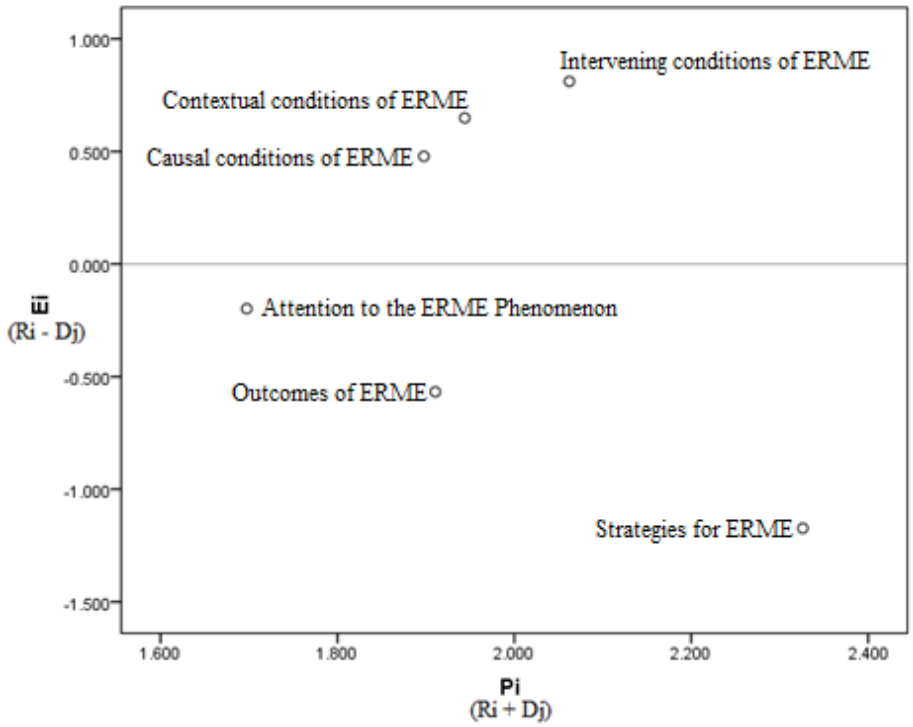

Figure 2. Overall Importance and Net Effects of Factors Based on Pi and Ei Values

Furthermore, an influence relation map can be constructed for the identified factors using data from the total relation matrix. T. To facilitate this, a threshold value θ It is determined to filter out negligible effects and enhance the interpretability of the resultant graph. In this study, the threshold was calculated as the sum of the mean and standard deviation of all elements in the matrix T, resulting in an optimal value of $\theta = 0.4131$. Only relationships where $t_{ij} \geq \theta$ were retained for network mapping. The final set of significant causal relationships is presented in Table 12.

Table 12. Total Relations Matrix with Selected Relationships Bolded

T	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Causal conditions of ERME	0.171	0.261	0.218	0.351	0.252	**0.454**
Contextual conditions of ERME	0.291	0.165	0.220	**0.500**	0.298	0.284
Intervening conditions of ERME	**0.468**	0.323	0.196	**0.606**	0.379	0.353
Strategies for ERME	0.233	0.246	0.207	0.255	**0.418**	0.268
outcomes of ERME	0.258	0.266	0.313	0.365	0.191	0.286
Attention to the ERME phenomenon	0.223	0.212	0.205	**0.503**	0.254	0.175

As demonstrated by the results, six causal relationships were found to exceed the established threshold value (θ = 0.4131). The influence-diagram network, presented in Figure 3, is therefore constructed exclusively from these significant relationships. In this diagram, a directed arrow from factor i to factor j signifies a direct and meaningful influence as derived from the total relation matrix.

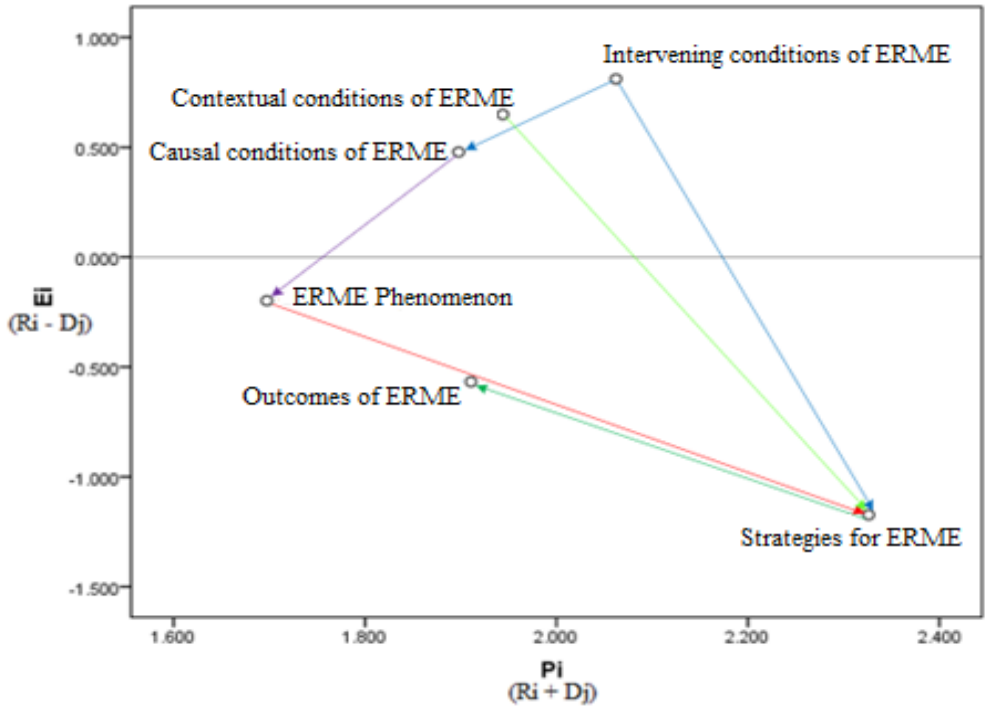

Figure 3. Influence diagram

Based on the influence diagram presented in Figure 3, the structural relationships and causal pathways within the risk management evaluation model can be clearly delineated. The analysis reveals that the "Causal Conditions of Risk Management Evaluation" serve as a foundational driver, directly influencing the "Focus on Risk Management Evaluation Phenomenon." This central focus, in turn, directly shapes the formulation and implementation of "Risk Management Evaluation Strategies." The effectiveness of these strategies is subsequently manifested in the "Outcomes of Risk Management Evaluation." Furthermore, the model identifies two critical conditioning factors: both "Contextual Conditions of Risk Management Evaluation" and "Intervening Conditions of Risk Management Evaluation" exert significant direct influences on the "Risk Management Evaluation Strategies," highlighting the importance of internal and external environments in strategic execution. A noteworthy recursive relationship is also observed, wherein the "Intervening Conditions of Risk Management Evaluation" directly impact the "Causal Conditions," suggesting a dynamic feedback loop within the system.

Conclusion

This study was designed to develop and articulate a comprehensive model for evaluating ERM in subsidiaries of selected Iranian cement holdings. The findings provide a detailed, multifaceted framework of the factors influencing ERM evaluation. The analysis identified that the "causal conditions" for ERM evaluation consist of five distinct sub-categories encompassing twenty-one specific properties: Risk-management Culture defined by managerial and employee belief in ERM, an explicit emphasis on workforce health, a supportive organizational culture, and formal risk-management strategies; Legal and Organizational Mandates driven by national governance and banking policies, international rules and requirements, and the imperative to maintain the firm's public image; Economic and Social Pressures characterized by the dictates of a resistance-economy paradigm, the compliance burden of standards and regulations, and foreign-exchange rate volatility; Intra-organizational Drivers motivated by the fulfilment of holdings' strategic objectives, technological upgrades in operational processes, safeguarding stakeholder interests, and enhancing organizational resilience; and Pre-existing Risks comprising hierarchical, control, strategic, appointment, disaster recovery, knowledge-related, and market-share loss risks.

The core of the model, "Attention to the ERM-evaluation Phenomenon," is structured around three sub-categories with ten properties, focusing on the accurate identification, evaluation, and effectiveness assessment of risks. The model further delineates intervening conditions (six sub-categories, 23 attributes) such as employee competencies, organizational climate, and managerial obstacles, and contextual conditions (three sub-categories, ten attributes) including industry complexity and national infrastructure. Five key ERM-evaluation strategies emerged (18 attributes), ranging from enhancing corporate capability and diffusing a risk-management culture

to risk avoidance, diversification, and transfer. The implementation of these strategies leads to four types of consequences (18 attributes): improved societal well-being, organizational continuity, growth, and profitability.

The application of Grey-DEMATEL analysis clarified the dynamic interrelationships among these dimensions, revealing six dominant causal pathways. This systemic view shows how causal conditions drive attention to ERM, which shapes strategies, which are themselves conditioned by contextual and intervening factors, ultimately producing the documented consequences. A feedback loop, where intervening conditions influence causal conditions, underscores the model's dynamic nature.

These findings offer a nuanced extension to existing empirical work. While Anton and Nucu (2020) linked ERM adoption to firm value, our model elaborates that this value is also intertwined with the cultivation of a public image. Furthermore, the study corroborates and contextualizes the findings of Klučka & Grünbichler (2020) on the informal alignment of risk and performance, by explicitly highlighting the critical, formal role of senior-management commitment and support as a key enabling factor within our framework. The strategic importance of human capital within this framework is further underscored by established links between professional management, talent retention, and national innovation capabilities (Ghasemi et al., 2018).

Practical Implications and Recommendations

The findings of this study provide concrete, actionable guidance for enhancing ERM implementation in the cement industry and related sectors. For corporate managers and holding company executives, we recommend four key actions: First, actively cultivate a proactive risk culture where leadership champions ERM beyond mere compliance, integrating risk-awareness into daily operations and strategic objectives, especially in critical areas like workforce safety and process integrity. Second, implement structured ERM frameworks with standardized protocols for systematically identifying, evaluating, and mitigating hierarchical, strategic, operational, and knowledge-related risks, supported by continuous monitoring. Third, establish cross-functional risk committees to ensure comprehensive risk assessment and coordinated response strategies across departments. Finally, explicitly align ERM activities with protecting stakeholder value through transparent communication on risk exposure and mitigation efforts.

For policymakers and regulatory bodies, this study suggests three pivotal initiatives: develop sector-specific ERM guidelines and maturity models tailored to the unique operational complexities and risk profiles of heavy industries, such as cement manufacturing. Introduce regulatory incentive mechanisms, such as linking permitting processes or offering preferential financing, to the demonstrated maturity of ERM, to encourage voluntary adoption. Furthermore,

promote standardized risk disclosure requirements in corporate reporting to enhance transparency and enable meaningful benchmarking across firms. Collectively, these evidence-based recommendations provide a clear roadmap for organizations to strengthen resilience systematically and for policymakers to foster a more robust and sustainable industrial ecosystem.

Limitations and Managerial Implications

This research is limited by its focus on cement holding subsidiaries in Iran, which may restrict the generalizability of the findings to other private firms. Furthermore, the grounded theory approach relies on accessing highly knowledgeable and motivated informants, a challenge encountered during this study.

For practitioners, the model offers a clear roadmap. It emphasizes that cultivating a genuine belief in ERM among managers and staff is a prerequisite for the successful implementation of ERM. Internal and external mandates, particularly state governance and banking directives, are key drivers that cannot be ignored. To ensure organizational continuity, risk initiatives must explicitly address the interests of all stakeholders. Finally, an effective ERM system must proactively target the specific risks identified - hierarchical, control, strategic, appointment, disaster recovery, knowledge, and market loss - thereby solidifying both the organization's resilience and competitive standing.

Data Availability Statement

Data are available upon request from the authors.

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Ethical considerations

The ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, have been completely witnessed by the authors.

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Conflict of interest

The authors declare no potential conflict of interest regarding the publication of this work.

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