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Identifying and Prioritizing the Factors Affecting Enterprise Risk Management Implementation

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Abstract

Enterprise risk management (ERM) represents a new paradigm that supports organizations in identifying, evaluating, and managing risks. Several factors encourage different organizations, especially banks, to design and apply ERM; among them, the possibility of financial problems and related costs, financial performance decline, growth opportunities, and independence of the board of directors can be pointed out. In addition, applying a suitable risk management strategy is a competitive advantage for supporting companies. Following the previous comprehensive studies, the present study was done by integrating a meta-composition approach and multivariate fuzzy network analysis. In this research, to identify effective factors on ERM based on empirical evidence and selection of studies, description and classification of selected articles, analysis of the content of selected research articles, and finally, the importance and refinement of the identified factors based on the Delphi expert opinion polling technique, and multivariate fuzzy network analysis was discussed. The study aimed to identify and rank the factors affecting the effectiveness of ERM of the firms accepted in selected banks in Iran. While reviewing studies, a semi-structured interview was conducted using an Exploratory-Descriptive Qualitative (EDQ) research design to determine the factors that affect ERM effectiveness. The interviewed experts were comprised of 20 university professors, CEOs, financial analysts of investment and brokerage companies, and senior auditors with accounting and management education. The literature review and the results of the interviews indicate five main themes that classify the factors affecting ERM effectiveness in firms. In this study, key factors were identified, and then the fuzzy Delphi technique was employed to rank and find the weight of the factors. The results showed that corporate governance, financial indicators, environmental indicators, company characteristics, and management indicators effectively enhance ERM's effectiveness. Accordingly, capital market analysts and investment companies should take a broader perspective and make decisions based on companies' financial risks instead of paying attention to companies' profitability and stock price changes. The results demonstrated that five factors determine ERM effectiveness: 1. corporate governance indicators (monitoring the board of directors and ownership structure), 2. Financial indicators (return on assets (ROA), earnings volatility, merger and acquisition (M&A) activities, financial deficiency, and capital opacity), 3. Environmental indicators (performance excellence, industry competition, audit firm credibility, environmental uncertainty, and industry), 4. Firm characteristics (financial leverage, firm size, and growth opportunities), and 5. Management indicators (management career and business diversity).

Keywords: Risk Management, Enterprise Risk Management Effectiveness, Prioritization, Fuzzy Delphi

Introduction

Today, organizations face many types of risks from different sources, such as globalization, deregulation, environmental changes, technological changes, complex financial models, and even changes in corporate governance. In such a dynamic environment, competitive advantage is considered one of organizations' most critical challenges. The improvement and development of competitive advantage depend significantly on improving organizations and management control systems. Organizations with robust management control systems and risk management will be better able to overcome the complexities of today's environment. Parallel to this problem, several studies have determined that Enterprise Risk Management (ERM) as a new method of organizational control system allows organizations to control different types of risks in a better and more complete way in various scopes and intensities. This issue includes strategic, operational, financial, and even harmful risks that the organization is unexpectedly involved with. In such a case, ERM is a system that helps organizations achieve a higher competitive advantage. This is done through the control, management, and organization of risk management activities, making the company's competitive advantage better and more accurate (Silva et al., 2019).

According to the Deloitte Global Risk Management Survey (2012), ERM compliance has been the most crucial issue in developed countries such as the United States of America, Canada, Australia, and European countries. In other words, developed countries have a higher ERM growth rate than developing countries (Sacks et al., 2021). Many researchers have tried to understand the relationship between ERM and wealth creation. For example, empirical findings by some researchers have determined that ERM and company performance have a significant positive relationship with each other (Prasad et al., 2018). In addition, Pop et al. (2021) found that ERM significantly reduces the company's capital costs and is the way through which the company creates added value for itself and increases the company's wealth.

In addition, Bertram reported that ERM enhances enterprise and financial values and benefits the company's shareholders and stakeholders. A review of ERM literature has shown that competitive advantage has not been considered a key factor for increasing corporate wealth. It raises the question of whether improvement in corporate risk management can improve competitive advantages within the organization and business (Oliveira et al., 2021). In addition, Barney (1991) believes that simultaneously, valuable and scarce resources can develop and improve competitive value. If these resources are

non-substitutable or non-imitable or cannot be easily searched, they can create a sustainable competitive advantage for the company. Such resources are called strategic resources or strategic assets of the company. In an overview of the above topics, it can be said that corporate risk management is a strategic asset of the company that can create a competitive advantage.

The present study aimed to investigate the increasing significance of ERM effectiveness in creating a robust corporate strategy system at the level of different organizations, especially banks. The research results may be helpful for organizations that implement ERM because this article can be used as a reference for researchers and practitioners who want to be informed about the relevant process according to the findings and empirical views. The interaction of ERM provides a general communication bridge between risk management, business strategy, goal setting, decision-making, and performance (Arena et al., 2010). The literature used in the research meta-synthesis section shows the ERM implementation at the regional and sector levels. The ERM implementation programs have become essential in various fields such as banks, insurance, and non-financial companies, especially small and medium-sized enterprises (SEMs). Developed economies, especially the US, have contributed the most in terms of empirical evidence on ERM implementation, the factors affecting it or its effects at the firm level, and at the same time, conducting research in other geographic regions, the trend is increasing. It has grown mainly due to the process of internationalization in this field (Anton & Nucu, 2021). Reviewing the research literature shows that conducting an extensive meta-analysis on ERM is rare, and it is limited to five studies conducted by Bromiley et al. (2015), Wu et al. (2015), Tworek (2016), Liff and Wahlström (2018) and Anton and Nucu (2021). The research innovation can be observed firstly in analyzing the latest collection of articles in a more extended period (2008-2021); second, contrary to previous studies, the selected articles are cited based on the most influential articles; and thirdly, contrary to Bromiley et al. (2015) which ignored reviewing the conceptual roots of ERM and the quality of scientists and researchers in management participate in relevant research, the present study focuses on the direction of future studies.

Enterprise risk management (ERM) represents a new paradigm that supports organizations in identifying, evaluating, and managing risks. As Khan et al. (2016) pointed out, several factors encourage different organizations, especially banks, to design and apply ERM: the possibility of financial problems and related costs, financial performance decline, growth opportunities, and board independence. In addition, a suitable risk management strategy can be considered a competitive advantage to support companies

(Blanco Mesa et al., 2019). Following Tranfield et al. (2003), Prasad et al. (2018), and Anton and Nucu (2021), the present study is conducted by integrating a meta-composition approach and multivariate fuzzy network analysis to identify factors effective on ERM based on empirical evidence and selection of articles, description, and classification of selected articles, analysis of the content of selected research articles, and finally, the weighting and refinement of the identified factors. The scope of the analysis covers the literature published on ERM from 2008 to 2021, indexed in the Web of Science (WoS) database.

Papi and Spekle (2021) identified several factors affecting ERM implementation. They pointed to factors including the regulatory environment, internal organizational factors, ownership structure, and firm and industry characteristics. Rahman and Anwar (2021) identified three structural factors in ERM implementation: management's commitment and expertise, effective communication and understanding, and the implementation method and its integration with other organizational processes. Some studies have identified some cases as effective factors that have a moderating role between the risk management characteristics of companies and companies. For example, competitive advantage mediates between ERM systems and corporate performance, while financial literacy moderates the relationship between ERM and competitive advantage (Yang et al., 2018). In addition, according to the empirical evidence obtained from Saeedi et al. (2020), implementing ERM has a positive link with firms' competitive advantage. Gordon et al. (2009) found five variables essential to the relationship between firm performance and ERM implementation: environmental uncertainty, industry competition, firm size, firm complexity, and board of directors' monitoring.

In general, the empirical evidence about ERM can be divided into four broad categories, which are: 1) implementation of ERM, 2) factors determining ERM acceptance, 3) effectiveness of ERM process, 4) other aspects such as ERM in different areas, ERM strategies, ERM maturity, the effect of institutional contexts on ERM acceptance, ERM acceptance of in family firms, and ERM as a moderating factor among different variables (Anton & Nucu, 2021).

At first, the present research reviewed the studies conducted in the field of ERM, and based on this, it emphasizes the identification of the determining factors in the field. Then, based on the mentioned research method, the classification, significance, and refinement of the identified factors based on the combination of Delphi persuasive polling of experts and the fuzzy

multivariate analysis method were discussed, and finally, the direction of future research and practical recommendations were proposed.

Literature Review

Theoretical framework

ERM implementation

In recent years, implementing ERM systems has become necessary in various areas, such as banks, insurance, and non-financial companies, especially SMEs. In this regard, one can refer to the growing research conducted in ERM in manufacturing and trading companies. For example, Strelkova et al. (2018) evaluated the ERM implementation process in 485 SMEs in the Slovak Republic, showing that only 75% of companies had dealt with risk management in some part of the companies, while 25% of the remaining companies had implemented risk management at all levels of activity. Arena et al. (2011) provided empirical evidence of implementing ERM at the level of several Italian companies and different industries. Fraser and Simkins (2016) investigated the problems of implementing ERM and provided solutions for conceptualizing and implementing such systems. Their results showed that misconceptions, internal challenges, organizational culture, knowledge and experience of the board of directors, identification of multiple risks, lack of time frame, non-recognition of ERM as a field of change management, and insufficient support of senior management are the current challenges.

Many studies analyze the relationship between ERM and firm performance (Silva et al., 2019; Zou et al., 2019). Some previous studies have done risk modeling in the framework of ERM at the level of a specific firm in the form of a case study. Enyinda (2018) and Braumann (2018) can be mentioned in this field. The content analysis of the literature shows that, unlike the richness of studies existing in implementing ERM at small and medium-sized manufacturing and commercial enterprises, studies examining the effect of ERM on the insurance industry and organizations such as banks or insurance companies are relatively few (Nguyen & Dinh-Tri, 2019; Durán Santomil & Otero González, 2020). Lundqvist and Vilhelmsson (2018) reported a negative relationship between ERM and credit default exchange in banks. In this study, conducted based on the performance data of a sample of 78 of the world's largest banks, the research results showed that implementing ERM reduces CDS spreads. Other studies have done risk modeling in the framework of ERM in the banking industry.

Baxter et al. (2013) investigated the factors affecting the quality of ERM implementation and their relationship with the firm performance and value in the banking and insurance industries. They showed that the ERM had improved the financial performance of the companies under investigation. In addition, Eckles et al. (2014) reported a decrease in the firm risk level and an increase in income and the level of collections for the insurance industry after ERM implementation. Fraser and Simkins (2016) discussed the consequences of the risk management system (RMS). The analysis of their research findings showed that ERM implementation has reduced the level of capital costs for companies active in the insurance industry in the US. Altuntas et al. (2019) provided information about risk management practices in the German insurance industry. In the framework of a survey plan based on a questionnaire survey of managers, they have studied the consequences of the RMS implementation. Based on the analysis of the results obtained from a survey, they showed that the ERM implementation has a positive effect on improving the level of income and collections of German insurance companies, and this effect was more significant in larger companies.

Yow and Sherris (2008) investigated the factors affecting the level of ERM acceptance by Australian insurers in a study conducted via survey research. Their results showed that friction and financial helplessness costs are among the factors affecting the level of acceptance of the ERM. Bohnert et al. (2019) conducted a significant positive relationship between ERM and enterprise value based on the performance of European insurers. Jabbour and Adel-Kader (2016) investigated the influence of institutional factors on ERM acceptance in the financial industry, including insurance companies and banks. They demonstrated that the companies that, compared to others, had made a decision earlier regarding the ERM implementation had internal motivations. In contrast, the companies that had recently decided to pursue this field had extra-organizational motivation, such as the requirements of regulatory bodies or the application of legal requirements.

Reviewing the literature shows that studies have employed four methods to measure ERM implementation: 1) Employing the senior risk manager or an equivalent position as a basis for the ERM implementation (Pagach & Warr, 2011); 2) Searching keywords in scientific databases such as LexisNexis and Dow Jones, seen in studies such as Prasad et al. (2018). In these studies, the search terms are ERM, senior risk manager, risk committee, strategic risk management, integrated risk management, comprehensive risk management, and integrated risk management. 3) Using the ERM rating provided by institutions such as Standard and Poor's (S&P Global Ratings) in connection

with organizations such as banks and insurance companies (e.g., Baxter et al., 2013; Eckles et al., 2014; Bohnert et al., 2019); 4) Survey of companies on assessing the level of ERM implementation (Yang et al., 2018).

Factors affecting ERM effectiveness

A group of studies focused on the effect of ERM implementation on corporate financial performance and the ERM functional consequences in improving firm performance, increasing market value, and reducing capital cost. Numerous extensive empirical studies have analyzed the relationship between ERM and firm performance, especially financially. Despite the different results, the prevailing view is that ERM implementation improves firm performance (Anton & Nucu, 2021; Silva et al., 2019; Zhu et al., 2019). A review of the research literature shows that most previous studies only provided empirical evidence from the United States (Khan et al., 2016; Liff & Gunner, 2018). Empirical research on European countries is minimal; their results show that ERM implementation in German (Eckels et al., 2014), Italian (Fraser & Simkins, 2016), Danish (Broman, 2018), Romanian (Anton & Nucu, 2021), and Spanish firms (Erena et al., 2011) increases.

Based on a sample of 112 American companies, Pagach and Warr (2011) showed that the relationship between risk management and firm performance depends on conditions. In addition, Silo et al. (2019) showed, based on non-financial firms, that ERM has a positive effect on the market value in the short term and is not a determinant of the market value in the long term. Moreover, Wu et al. (2015) demonstrated that non-financial firms in the United States did not enjoy the positive effects of ERM in the short term, and its positive effects on firm financial performance were not significant in the long term. Strelcova et al. (2018) showed that ERM implementation increases the shareholders' wealth by at least 20 percent. During a similar study, Yang et al. (2018) also showed that ERM implementation can create added value in organizations such as companies admitted to the German stock exchange. Sax and Andersen (2021) provided evidence of a significant relationship between ERM implementation and increased profitability and reduced financial leverage of the largest Danish companies. In addition, Tranfield et al. (2003) also found a positive relationship between the ERM acceptance level and firm financial performance and the market value of companies listed on the Italian Stock Exchange.

Based on a sample of Romanian non-financial listed companies, Anton and Nucu (2021) emphasized that ERM implementation is related to improving enterprise value. However, during the financial crisis, empirical findings

showed that ERM does not affect the enterprise value. No relationship between ERM quality and firm market performance during the global financial crisis of 2007-2008 was reported by Baxter et al. (2013). In addition, the literature shows that ERM implementation positively affects the performance of SMEs in emerging economies (Silva et al., 2019; Erna et al., 2011). Via a study on the performance data of Nigerian non-financial firms, Ahmad and Manab (2021) showed that ERM implementation has significant positive effects on firm non-financial performance. Yang et al. (2018) investigated the relationship between ERM implementation or acceptance and firm performance in Pakistan, considering the mediating role of competitive advantage and moderating financial literacy. Findings showed that the firms that implemented the ERM systems had a superior performance compared to similar firms. Also, during an experimental study, Zou et al. (2019) obtained similar results for SMEs in southern Thailand.

Based on a sample of large financial firms, including insurance companies, Ali et al. (2021) demonstrated that ERM quality is an essential determinant of performance. Altuntas et al. (2019) also found a positive and significant relationship between ERM and firm performance based on firms active in the Malaysian oil and gas industry. Based on performance data from a sample of 152 Malaysian SMEs, Bohnert et al. (2019) showed that ERM acceptance significantly affects sales performance. Similarly, Silva et al. (2019) also found a positive relationship between enterprise value and ERM implementation in Brazilian companies listed on the stock market. However, Jabbour and Abdel-Kader (2016) depicted that in high-risk firms, the added value of ERM is limited and does not always produce financial results for the Polish economy. Khan et al. (2016) analyzed the dimensions of the effects of ERM on increasing enterprise value. The results indicated that using economic capital models and dedicated risk managers under the board of directors or the executive director positively affects the enterprise value.

The review of the research literature shows that most of the previous studies have investigated the effect of ERM on a firm financial performance and market value. However, only a few studies have analyzed the effect of ERM on non-financial firms (Prasad et al., 2021; Sax & Andersen, 2021). This section of the research literature on the value creation of ERM acceptance has presented several arguments to explain this relationship: ERM provides an effective method to improve various ERM activities (Silva et al., 2019); ERM implementation increases investment efficiency (Silva et al., 2019); ERM implementation reduces the challenge of small investment in companies with financial constraints, lowers the cost of external financing, and ultimately

reduces the uncertainty in stock market returns (Eckles et al., 2014).

Therefore, ERM implementation improves firm performance and reduces risk exposure (Fraser & Simkins, 2016). Also, based on the empirical evidence provided by Enyinda (2018), ERM implementation positively affects the reputation and credibility of Spanish firms. According to Liff and Wahlström (2018), ERM implementation harms the cost of capital (COC), and the cost of financing the firm decreases after ERM implementation. Among the reasons for this are: 1) ERM implementation increases the information related to the risk characteristics of companies; 2) ERM implementation reduces the level of systematic risk; and 3) ERM implementation is focused on reducing the probability of loss. Therefore, it reduces the need to attract foreign capital and positively affects the expected COC. Guidance for companies that seek to understand capital allocation decisions under ERM operations, in business units and types of risk (Ali et al., 2021); 4) Eckles et al. (2014) showed that ERM implementation leads to the reduction of the final cost and, as a result, the risk reduction; 5) also, risk disclosure is increasing after ERM implementation (Arena et al., 2011). A survey among top Danish firms shows ERM implementation improves risk performance (Sax & Andersen, 2021).

Another group of studies also focus on other aspects of ERM. Some studies examine risk management strategies in different fields such as agriculture (Silva et al., 2019), supply chain (Nguyen & Dinh-Tri, 2019), bus market (Lundqvist & Vilhelmsson, 2018), audit process (Jabbour & Abdel-Kader, 2016), production planning (Wu et al., 2015), pharmaceutical industry (Yow & Sherris, 2008) and transportation (Zu et al., 2019). The general conclusion in the studies mentioned above is towards ERM formalization. Some studies examined ERM maturity in different areas (Turk, 2016) or ERM strategies (Tranfield et al., 2003). Jabbour and Abdel-Kader (2016) investigated the effect of institutional pressure on ERM acceptance in the insurance industry. Santomil and Gonzalez (2020) showed one of the first analyses of ERM adoption in family firms from Austria and Germany.

et al. (2018) investigated the role of ERM as a potential moderating factor in the relationship between external financing activities and earnings management of companies listed on the Taiwan Stock Exchange from 2004-2015. This research showed that managers use actual activities and accruals in profit management while financing activities. Wu et al. (2015) reported the significant moderating role of the relationship between firm flexibility and firm performance. As Rahman and Anwar (2021) demonstrated, ERM, to some extent, mediates the relationship between business strategy and the performance of SMEs. ERM implementation can also have a moderating role

in today's business context.

Many previous studies have analyzed the factors determining the acceptance or effectiveness of ERM systems. Table 1 summarizes the factors affecting investment in ERM implementation plans.

Table 1. Summary of factors determining the ERM effectiveness

Previous studies and their findings	Relationship	Variable
Larger firms have an overview of risk identification and can implement ERM in several business units. Several findings regarding the possibility of ERM implementation (Nguyen & Dinh-Tri, 2019).	Positive	Firm size
There is a positive relationship (Prasad et al., 2018) and a negative relationship (Sax & Andersen, 2021) between financial leverage and ERM implementation. ERM implementation requires financial resources and is more accessible in firms with less leverage. ERM implementation has led to improved risk assessment and reduced debt costs, so companies may decide to increase their financial leverage.	Positive or negative	Financial leverage
ERM implementation in firms with more growth opportunities is more important because ERM programs support preserving the franchise's value (Silva et al., 2019).	Positive	Growth opportunities
There is a negative relationship between the level of ownership and the probability of ERM implementation in firms because additional capital may not be available for investing in such a program (Tranfield et al., 2003).	Negative	Mergers and acquisitions (M&A)
The return on assets (ROA) is known as an indicator of management efficiency, and it is expected that companies with higher ERM will allocate more financial resources for ERM implementation (Wu et al., 2015).	Positive	Return of assets (ROA)
Firms with high capital opacity and facing more financial constraints are more likely to implement ERM (Yang et al., 2018).	Positive	Turbidity of capital
ERM implementation in firms with unstable profits can have many advantages, including improving the volatility of profits (Zou et al., 2019).	Positive	Profit volatility
An increase in financial deficiency may encourage firms to invest in ERM implementation (Tworek, 2016; Pagach & Warr, 2011).	Positive	Financial shortage
ERM implementation improves profitability information and provides a signal of management capabilities (Wu et al., 2015).	Positive	Management career
Due to increased performance and reduced risk, there is a positive relationship between business diversification and ERM implementation from both industrial and international perspectives (Yang et al., 2018). On the other hand, increased industrial diversity can cause information loss within enlarged	Negative or positive	Diversity of business

groups, while global diversity may cause representativeness problems (Silva et al., 2019).		
Some specific industries are more inclined to implement ERM due to legal requirements (Sacks & Traban, 2021). Banking and the insurance industry are under regulatory frameworks such as the Basel Agreements and Solvency II, and energy is another area with severe risk requirements (Prasad et al., 2018).	Positive	Industry
Taking advantage of the audit services of large and reliable institutions encourages companies to implement ERM (Nguyen & Dinh-Tri, 2019).	Positive	Credibility of the auditing firm
The superiority of financial performance according to the classification of organizations, such as the stock exchange, encourages companies to implement ERM (Nguyen & Dinh-Tri, 2019).	Positive	Performance excellence
The higher the profit volatility, the more valuable ERM implementation becomes (Liff & Gunner, 2018).	Positive	Environmental uncertainty
As ERM implementation becomes more valuable, the industry becomes more competitive (Khan et al., 2016).	Positive	Competition in the industry
With the increase in the size and activity of the board of directors, the firm has become more interested in implementing ERM (Fraser & Simkins, 2016).	Positive	Monitoring by the board of directors
Firms with non-family ownership are more interested in ERM implementation (Baxter et al., 2013).	Positive	Ownership structure

Leaf and Gunner (2018) analyzed the effect of organizational culture on the effectiveness and success of ERM implementation. The purpose of this research was to answer the question, which type of corporate culture is more suitable for the effectiveness of the implementation of the ERM system? They showed that the effectiveness and success of the ERM implementation have a positive relationship with the organic culture. Lundqvist (2015) showed that the mechanisms of the corporate strategy system also determine the effectiveness of ERM implementation.

In general, the ERM system is a complex process, and in this regard, the results obtained by Gordon et al. (2009) indicated that three factors affect the effectiveness and success of ERM implementation. These factors include the risk management cycle, the classification of risk communication, and the ERM maturity model. It is worth mentioning that the details of the indicators and criteria used in the ERM process can be seen in Khan et al. (2016). Finally, Olivera et al. (2021) demonstrated that a comprehensive approach is presented concerning the determining factors of the effectiveness of ERM implementation.

Research Methodology

The applied study employed an Exploratory-Descriptive Qualitative (EDQ) research design and semi-structured interviewing technique. The present study is descriptive in terms of the data collection method because it aims to describe the conditions and phenomena under investigation, and its implementation is done to understand the existing conditions better and help the decision-making process.

The statistical population of the research in both the qualitative and quantitative sections were banking experts with sufficient knowledge and experience in ERM. The sampling method in the qualitative part was a snowball sampling technique for selecting 20 banking experts selected via a data saturation technique. The data collection instrument for the qualitative part was a semi-structured interviewing technique, and in the quantitative part, a researcher-made questionnaire with seventeen factors based on a 5-point Likert scale and open-ended questions for each main factor. The fuzzy Delphi technique was employed in the quantitative part to rank the factors affecting risk management. For qualitative data analysis, thematic analysis was employed; for quantitative data, Excel and MATLAB software were used.

The Fuzzy Delphi technique was employed to identify and screen the most important factors. This technique is based on the participants' opinions. This technique uses verbal expressions to measure the participants' viewpoints. Verbal expressions have limitations in fully reflecting the respondents' mental states. For example, the expression "much" for person A, who is strict, differs from "much" for person B. If a definite number is used to quantify the views of both individuals, the results will be biased. Therefore, this problem can be overcome by developing a suitable phase spectrum. The traditional Delphi method has always suffered from low convergence of experts' opinions, high implementation cost, and the possibility of omitting some people's opinions. To improve the traditional Delphi method, Murray et al. (1985) presented the concept of integrating the conventional Delphi method with fuzzy set theory.

In the fuzzy Delphi technique, the experts' opinions are used to reach a consensus among their opinions. The participants in the present study are specialists and experts with knowledge and experience in ERM, so they feel that the data obtained from a group agreement is valuable. Also, they have the desire, enough time, and effective communication skills to participate in the study.

To collect the data, a researcher-made questionnaire including seventeen

effective factors was prepared based on a Likert scale and open-ended questions in each main factor to state if there is another one they are interested in. The face validity determined the instrument validity. After its design in terms of appearance and ease of answering, the questionnaire was approved by industry and university experts, including managers and professors. Microsoft Excel and MATLAB were employed to analyze the obtained results. The study was done via field studies in a research time frame of three months in the summer of 2021. According to the definition of the subject in the form of companies listed on the stock exchange, the research area was the Tehran Stock Exchange.

Results

Data analysis and findings

Demographic findings

Considering that the demographic characteristics of a statistical sample can be used in generalizing the results to other statistical communities by considering the similarities in general characteristics, among the sample of 20 individuals, all 20 (100%) members of the statistical sample were male. Three individuals, 15% of all members of the statistical sample, were single; the rest, seventeen individuals (85%), were married. 13 individuals (65%) were 30 to 40 years old, and five ones (25%) were between 40 to 50 years old. Also, one individual (5%) was less than 30 years old, and one individual (5%) was more than 50 years old, and the frequency of these two classes is 5%. 8 individuals (40%) held an MD, and the number of those who were an PhD and master's students were 7 (35%) and 5 (25%), respectively. Seven individuals (35%) completed their studies in the field of accounting, and the rest were in the field of financial management. Eight individuals (40%) had 10 to 15 years of experience, four individuals (20%) had 15 to 20 years of experience, and two individuals (10%) had more than 20 years of experience. Also, 30% of the sample had less than ten years of experience.

Factors affecting ERM implementation

Reviewing the literature, conducting the interviews, and confirming the experts' (university professors') opinions, the mentioned propositions were classified in the form of five main themes and seventeen sub-themes: the main themes were firm (bank) characteristics, financial, management, environmental, and corporate governance indicators. Figure 1 illustrates the factors affecting ERM implementation.

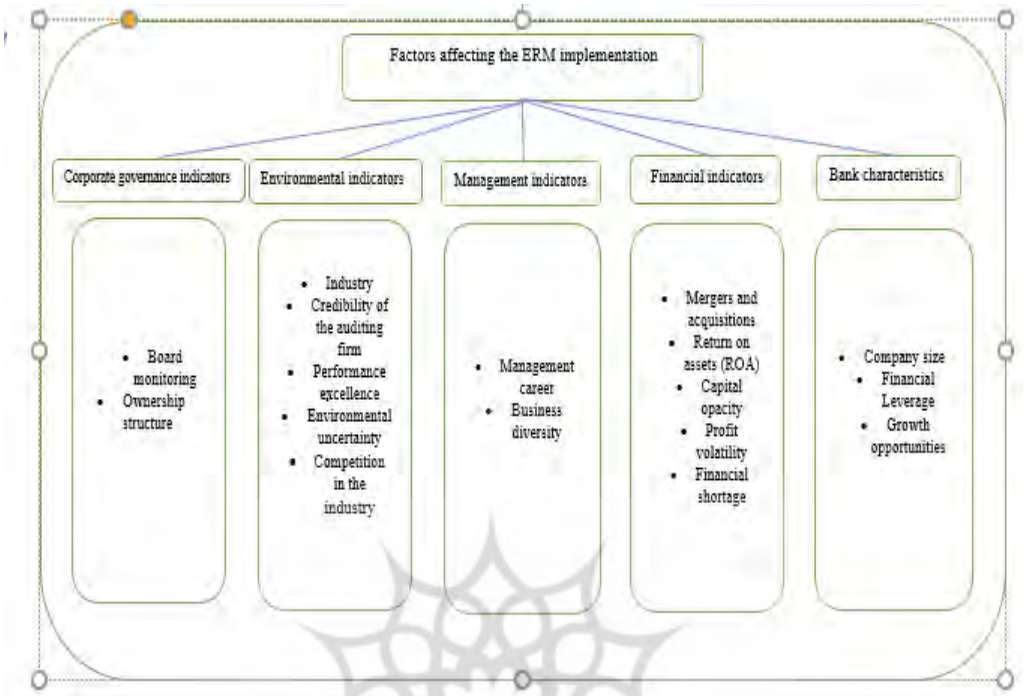

Figure 1. Factors affecting ERM implementation

Defining the linguistic variables

After interviewing the participants and identifying the factors affecting ERM implementation, the components were designed as a questionnaire to obtain experts' opinions about their agreement with the components. The experts expressed their level of agreement through the linguistic variables very low, low, moderate, high, and very high. Since the different characteristics of people affect their subjective interpretations of qualitative variables, by defining the scope of qualitative variables, experts answered questions with the same mentality. According to Figure 2 and Table 2, these variables are defined as triangular fuzzy numbers.

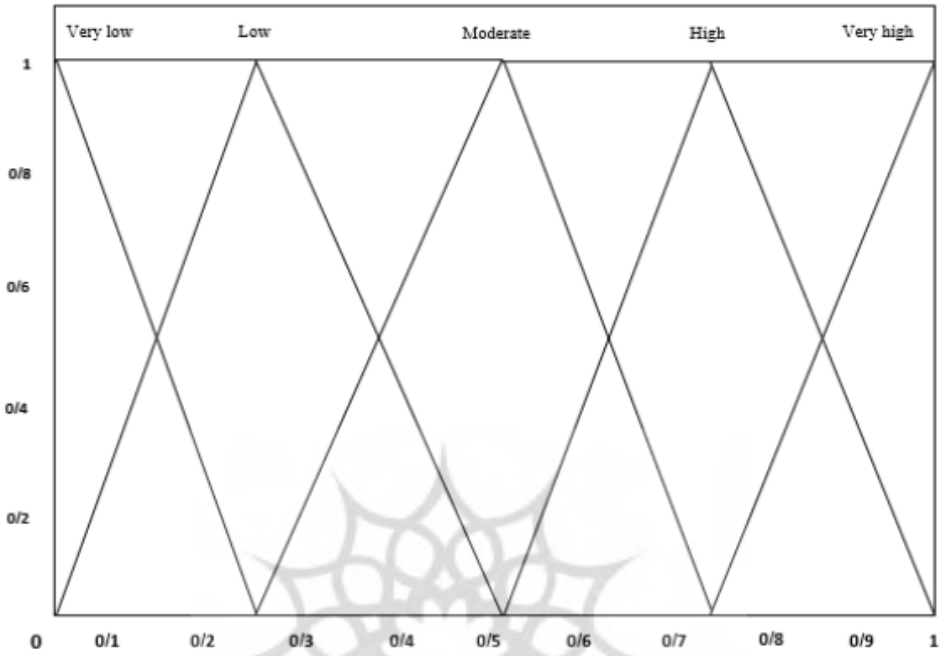

Figure 2. Defining the linguistic variables (Mousavi et al., 2019)

Table 5 displays how to convert linguistic variables into triangular and deterministic fuzzy numbers.

Table 2. Triangular fuzzy numbers

Linguistic variables	Triangular fuzzy numbers	Determined fuzzy number
1	(0.75, 1, 1)	0.75
2	(0.5, 0.75, 1)	0.5625
3	(0.25, 0.5, 0.75)	0.3125
4	(0, 0.25, 0.5)	0.0625
5	(0, 0, 0.25)	0.0625

The determined fuzzy numbers in Table 2 are calculated using the Minkowski spacetime as follows.

$$m + \frac{\beta - a}{4} \quad (1)$$

Where m, a, and β are the first, second, and third numbers from left to right, respectively.

First stage survey

At this stage, the factors affecting ERM implementation, identified using semi-structured interviews with the experts, were provided to the experts via a questionnaire. According to the proposed option and the defined linguistic variables, the results obtained from examining the answers given in the questionnaire were analyzed to get the fuzzy average of the factors affecting ERM implementation. The following equations are employed to calculate the fuzzy average:

$$A_i = \left(a_1^{(i)}, a_2^{(i)}, a_3^{(i)}\right), i = 1,2,3, \dots, n \quad (2)$$

$$A_{ave} = (m_1, m_2, m_3) = \left(\frac{1}{n}\sum_{i=1}^{n} a_1^{(i)}, \frac{1}{n}\sum_{i=1}^{n} a_2^{(i)}, \frac{1}{n}\sum_{i=1}^{n} a_3^{(i)}\right) \quad (3)$$

In Equation 2, Ai represents the experts' opinions, and Aave is the opinions' average. After returning the questionnaires, the number of answers given to each factor was counted and checked. In the first stage of the survey, the results of counting the answers given are shown in Table 3.

Table 3. The results of counting the answers in the first stage of the survey

Variables	Very high	High	Moderate	Very low	Low	Variables	Very high	High	Moderate	Very low	Low
Firm size	3	7	9	0	0	Business diversity	3	4	8	4	1
Financial leverage	6	8	5	1	0	Industry	5	5	4	4	2
Growth opportunities	4	7	7	1	1	Credibility of the auditing firm	7	5	4	3	1
Mergers and acquisitions (M&A)	3	6	7	3	1	Performance excellence	14	3	3	0	0
Return on assets (ROA)	18	2	0	0	0	Environmental uncertainty	2	8	4	3	3
Capital opacity	4	5	5	6	0	Competition in the industry	7	7	4	1	1
Profit volatility	17	2	1	0	0	Monitoring by the board of directors	10	7	1	2	0
financial shortage	5	8	3	3	1	Ownership structure	11	6	2	1	0
Management career	10	4	4	2	0						

After the number of answers to the factors affecting ERM implementation was determined, the triangular fuzzy average for the factors was calculated, and the Minkowski spacetime and determined fuzzy numbers were employed to calculate each factor. The results of the fuzzy average and de-fuzzification of the components are shown in Table 4.

Table 4. The experts' average opinions obtained from the first stage of the survey

Variables	Triangular fuzzy average (m, α, β)	De-fuzzified average	Variables	Triangular fuzzy average (m, α, β)	De-fuzzified average
Firm size	(0.888 and 0.675 and 0.425)	0.478	Business diversity	(0.763 and 0.550 and 0.313)	0.366
Financial leverage	(0.913 and 0.738 and 0.488)	0.531	Industry	(0.775 and 0.588 and 0.363)	0.409
Growth opportunities	(0.850 and 0.650 and 0.413)	0.463	Credibility of the auditing firm	(0.838, 0.675 and 0.438)	0.478
Mergers and acquisitions (M&A)	(0.800 and 0.588 and 0.350)	0.403	Performance excellence	(0.963 and 0.888 and 0.638)	0.656
Return on assets (ROA)	(1 and 0.975 and 0.725)	0.731	Environmental uncertainty	(0.763 and 0.538 and 0.325)	0.381
Capital opacity	(0.788 and 0.588 and 0.338)	0.388	Competition in the industry	(0.888 and 0.725 and 0.488)	0.528
Profit volatility	(0.988 and 0.950 and 0.700)	0.709	Monitoring by the board of directors	(0.938 and 0.813 and 0.563)	0.594
financial shortage	(0.850 and 0.663 and 0.425)	0.472	Ownership structure	(0.950 and 0.838 and 0.588)	0.616
Management career	(0.900 and 0.775 and 0.525)	0.556			

At the end of the first stage of the survey, it is necessary to conduct the second stage of the survey to compare the results obtained from both stages and determine the result.

Second stage survey

In the second stage of the survey, the results of counting the answers to the factors affecting ERM implementation are presented in Table 5.

Table 5. The results of counting the answers to the second stage survey

Variables	Very high	High	Moderate	Very low	Low	Variables	Very high	High	Moderate	Very low	Low
Firm size	4	6	۸	1	1	Business diversity	4	3	6	5	2
Financial leverage	7	6	4	2	1	Industry	3	5	5	5	2
Growth opportunities	4	6	6	3	1	Credibility of the auditing firm	8	3	4	5	0
Mergers and acquisitions (M&A)	4	5	8	1	2	Performance excellence	11	5	4	0	0
Return on assets (ROA)	19	1	0	0	0	Environmental uncertainty	3	6	6	3	2
Capital opacity	5	4	5	6	0	Competition in the industry	8	6	4	1	1
Profit volatility	۱۷	3	0	0	0	Monitoring by the board of directors	11	6	2	1	0
financial shortage	4	7	3	4	2	Ownership structure	12	5	1	1	1
Management career	11	2	4	3	0						

After determining the number of answers given to the factors affecting ERM implementation in the second stage and calculating the triangular fuzzy average for the factors, it was calculated from the Minkowski spacetime and determined fuzzy numbers for each component. The results of the fuzzy average and de-fuzzification of factors in the second stage are shown in Table 6.

Table 6. The experts' average opinions obtained from the second stage survey

Variables	Triangular fuzzy average (m, α, β)	De-fuzzified average	Variables	Triangular fuzzy average (m, α, β)	De-fuzzified average
Firm size	(0.838 and 0.638 and 0.400)	0.450	Business diversity	(0.725 and 0.525 and 0.300)	0.350
Financial leverage	(0.863, 0.700 and 0.463)	0.503	Industry	(0.738 and 0.525 and 0.300)	0.353
Growth opportunities	(0.813, 0.613 and 0.375)	0.425	Credibility of the auditing firm	(0.825 and 0.675 and 0.425)	0.463
Mergers and acquisitions (M&A)	(0.800, 0.600 and 0.375)	0.425	Performance excellence	(0.950 and 0.838 and 0.588)	0.616
Return on assets (ROA)	(1, 0.988 and 0.738)	0.741	Environmental uncertainty	(0.775 and 0.563 and 0.338)	0.391
Capital opacity	(0.788, 0.600 and 0.350)	0.397	Competition in the industry	(0.888 and 0.738 and 0.500)	0.538
Profit volatility	(1, 0.963 and 0.713)	0.722	Monitoring by the board of directors	(0.950 and 0.838 and 0.588)	0.616
financial shortage	(0.788, 0.588 and 0.363)	0.413	Ownership structure	(0.925 and 0.825 and 0.588)	0.613
Management career	(0.875, 0.763 and 0.513)	0.541			

After completing the first and second-stage surveys, the difference between the de-fuzzified averages of the factors affecting ERM implementation should be analyzed. Examining the difference of the de-fuzzified average of factors affecting ERM implementation in the first and second stages is described in Table 7.

Table 7. The de-fuzzified average difference between the first and second-stage surveys

Variables	The de-fuzzified average of the first-stage survey	The de-fuzzified average of the second-stage	De-fuzzified average difference of the first and second-stage	Variables	The de-fuzzified average of the first-stage survey	The de-fuzzified average of the second-stage	De-fuzzified average difference of the first and second-stage
Firm size	0.478	0.450	0.0281	Business diversity	0.366	0.350	0.0156
Financial leverage	0.531	0.503	0.0281	Industry	0.409	0.353	0.0563
Growth opportunities	0.463	0.425	0.0357	Credibility of the auditing firm	0.478	0.463	0.0156
Mergers and acquisitions (M&A)	0.403	0.425	0.0219	Performance excellence	0.656	0.616	0.0406
Return on assets (ROA)	0.731	0.741	0.0094	Environmental uncertainty	0.381	0.391	0.0094
Capital opacity	0.388	0.397	0.0094	Competition in the industry	0.528	0.538	0.0094
Profit volatility	0.709	0.722	0.0125	Monitoring by the board of directors	0.594	0.616	0.0219
financial shortage	0.472	0.413	0.0594	Ownership structure	0.616	0.613	0.0031
Management career	0.556	0.541	0.0156				

According to the opinions presented in the first-stage survey and compared with the results of the second-stage survey, if the de-fuzzified average difference in both stages is less than 0.1, the survey process is stopped. Considering that the de-fuzzified average difference of the experts' opinions in both stages is less than 0.1, the experts reached a consensus on the factors affecting the effectiveness of risk management, and the survey was stopped at this stage-- the experts had almost the same opinions on the components and dimensions identified in the research. According to the mentioned contents, the ranking of factors effective on ERM implementation is shown in Table 10. In ranking the components, the fuzzified average of the second stage survey is used; that is, any component whose de-fuzzified average is higher is given priority.

Conclusion

Financial forecasts are challenging issues devoted to valuable studies in recent decades. The occurrence of the recent financial crisis in large companies around the world has intensified the need to modify the existing financial architecture. It is generally believed that warning signs and alarms may be seen before businesses face an economic problem or crisis. The general goal of identifying the factors affecting risk management in firms or a business is to create models that can extract knowledge related to risk assessment from past observations and assess the business crisis risk of companies with a much broader scope. This evaluation identifies new international financial architecture policies such as crisis prevention, crisis forecasting, and crisis management methods. In this research, an attempt has been made to conduct a systematic and comprehensive study to identify the parameters that may be effective in ERM implementation, and a complete database of these parameters is provided. For this purpose, all the accounting variables and components affecting ERM implementation will be examined by summarizing the research literature and, in other words, by examining the field of knowledge. In this research, the authors aim to identify the factors affecting the ERM implementation of Refah Bank by studying the existing literature and interviewing experts. After conducting interviews and reviewing existing studies, the initial factors were identified. Via theme analysis, the factors identified after several stages were gathered in the form of central themes. By taking from the studies and examining the different divisions of the five factors of firm characteristics, financial indicators, management indicators, environmental indicators, and corporate governance, the indicators related to the factors were also identified and classified. Finally, the fuzzy Delphi technique prioritized relevant factors and indicators.

This research raises two general questions: First, what factors affect ERM implementation in companies? And secondly, how was the prioritization of effective factors, and how important is each factor? According to the results, among the main factors affecting the ERM implementation of companies, in the order of priority: 1. corporate governance indicators, 2. Financial indicators, 3. Environmental indicators, 4. Firm characteristics, and 5. Management indicators skills play a role in the firms' ERM implementation.

The order of priority of the corporate governance indicators effective in the corporate governance component is as follows: 1. Monitoring by the board of directors, and 2. Ownership structure. The order of priority of the financial

indicators effective in the financial component is as follows: 1. Return on assets (ROA), 2. Volatility of profits, 3. Acquisition and merger activities, 4. Lack of finance, and 5. Capital opacity. Among the environmental indicators, in the order of priority, there are: 1. Performance excellence, 2. Competition in the industry, 3. The credibility of the auditing firm, 4. Environmental uncertainty, and 5. The industry is effective in the environmental component. In order of priority, firm characteristics are: 1. Financial leverage, 2. Corporate size, and 3. Growth opportunities play a role in the effectiveness of the corporate characteristics component. Finally, among management indicators, in the order of priority, management career and business diversity play a role in the effectiveness of the components of management indicators.

The research results demonstrated that it is possible to identify the factors affecting the effectiveness of ERM implementation in firms based on the knowledge domain analysis and the content analysis model via integrating the Delphi expert opinion polling technique and multivariate fuzzy network analysis; more effective factors can be refined. Based on this, capital market analysts and investment companies should take a broader perspective and make decisions based on the firms' financial risk instead of paying attention to the companies' profitability and stock price changes. In this case, they can make their assessment multi-dimensional and measure ERM based on identified and refined factors in the dimensions of 1. Corporate governance indicators (monitoring the board of directors and ownership structure), 2. Financial indicators (return on assets (ROA), profit volatility, mergers and acquisitions (M&A), lack of finance and capital opacity), 3. Environmental indicators (performance superiority, competition in the industry, credibility of the auditing firm, environmental and industry uncertainty), 4. Firm characteristics (financial leverage, firm size, growth opportunities), and finally, 5. Management indicators (management career and business diversity). More comprehensive decisions will be made based on the experts' opinions and scientific foundations in this case. The research results can be consistent with Prasad et al. (2018), Rahman and Anwar (2021), Sax and Andersen (2021), Anton and Nucu (2021), and Ali et al. (2021).

This study used knowledge analysis and content analysis techniques to identify the factors affecting the companies' ERM effectiveness. Expert opinion polling was employed using the fuzzy Delphi method. Other researchers are suggested to use methods such as fuzzy TOPSIS or fuzzy network analysis. In addition, information theory believes that each financial and accounting variable or ratio can convey specific functional information to a

decision-maker. Accordingly, it is possible to provide a different ranking of the companies and a different picture of the ERM of the companies listed on the Tehran Stock Exchange. Also, the research results can be used by rating agencies that have started to operate. Future researchers are advised to use composite criteria such as entropy to combine different and sometimes contradictory criteria to judge firms' ERM.

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