Petroleum Business Review, Vol. 7, No. 4, pp. 86–102, October 2023

Identifying the Factors Effective in Issuing Catastrophic Bonds in Iran's Oil and Gas Industry Using the Delphi Method

Mohammad Reza Kazemi Najaf Abadi[1*], Mohammad Mahdi Hajian[2], Mohammad Hashem Bot Shekan[3], and Ghadir Mahdavi[4]

[1]Ph.D. Student, Faculty of Law and Political Sciences, Allameh Tabataba`i University, Tehran, Iran
[2]Assistant Professor, Faculty of Law and Political Sciences, Allameh Tabataba`i University, Tehran, Iran
[3]Associate Professor, Faculty of Management and Accounting, Allameh Tabataba`i University, Tehran, Iran
[4]Associate Professor, Faculty of Insurance, Allameh Tabataba`i University, Tehran, Iran,

Highlights

- Catastrophe bonds can resolve inefficiency in the insurance and reinsurance industry;
- The oil and gas industry must use catastrophe bonds to transfer the risk to the capital market;
- This work uses the Delphi method;
- The six effective categories for issuing catastrophe bonds in Iran's oil and gas industry include legislation and amendment of the rules, knowledge management, process management, transparency, creation and strengthening of software platforms, and cultivation.

Received: November 01, 2022; *revised:* May 01, 2023; *accepted:* July 04, 2023

Abstract

One of the innovations that has been formed in the insurance industry in recent years is risk transfer to the capital markets. Today, this possibility is provided by issuing insurance bonds and catastrophe (CAT) bonds, the most critical type of insurance-linked securities (ILS), and can redress inefficiency in the insurance industry. Today, more and more catastrophe bonds are being issued worldwide, which investors and insurance companies welcome. On the other hand, traditional insurance solutions to cover the risks of Iran's oil and gas industry are not efficient or sufficient, and using CAT bonds to transfer the risks of this industry to capital markets is necessary and inevitable. This work aims to identify influential factors for issuing catastrophe bonds in Iran's oil and gas industry. Based on this and after reviewing the literature through library studies, 33 factors were identified in 7 categories based on the similarities. Then, based on the Delphi method, experts were asked to express their opinions through an iterative questionnaire. After taking the experts' views in every round, the statistics analysis was performed, and the Delphi process was stopped in the third round. Based on the results, 32 factors in 6 categories, namely legislation and amendment of the rules, knowledge management, process management, transparency, creation and strengthening of software platforms, and cultivation, were approved by the experts and identified as influential factors for issuance of CAT bonds in Iran's oil and gas industry.

Keywords: Catastrophe Bonds, Risk, Insurance, Oil and Gas Industry

How to cite this article
Kazemi Najaf Abadi, M.R., Hajian, M.M., Bot Shekan, M.H., Mahdavi, Gh., Identifying the Factors Effective in Issuing Catastrophic Bonds in Iran's Oil and Gas Industry Using the Delphi Method, Petroleum Business Review, Vol. 7, No. 4, p. 88–107, 2023. DOI: 10.22050/pbr.2023.365404.1282

* Corresponding author:
Email: kazemi1264@gmail.com

1. Introduction

In the 1990s, a series of natural disasters in the United States, including Hurricane Andrew and the Northridge earthquake, firstly raised questions about the adequacy of the insurance industry's financial capacity to cover large catastrophes without limiting coverage or substantially raising premiums and secondly called attention to ways of raising additional sources of capital to help cover catastrophic risk.

Catastrophe (CAT) bonds have long been hailed as securitization vehicles that can increase global risk financing capacity by transferring catastrophe risks to capital markets. Climate change and human intervention have increased the magnitude and frequency of natural disasters that affect all aspects of economic activity, raising concern about environmental issues such as sustainability and human-nature symbiosis (Kiohos and Paspati, 2021) and cause massive economic losses to which reinsurance and insurance companies hardly respond. CAT bonds are an efficient instrument for risk hedging and, at the same time, attractive to financial market investors. Despite a few repetitions, the design and use of insurance securities to cover risks and uncertainties cause significant losses.

On the other hand, Iran's massive oil and gas reserves and unique geographical and geopolitical position in reaching the world's major consumer markets have made Iran one of the world's most influential countries with hydrocarbon reserves. According to the OPEC Annual Statistical Bulletin in 2020, Iran's proven crude oil reserves are 208.60 billion barrels, and Iran is in the third position after Venezuela and Saudi Arabia.

At the same time, upstream oil and gas projects have two characteristics, and they are usually associated with high economic returns; on the other hand, they are highly risky due to the risk and uncertainty of technical and economic parameters affecting project efficiency. The simultaneous presence of these features, the diversity of investment opportunities, and the limited financial resources make it necessary to manage and allocate financial resources optimally (Alimoradi et al., 2021). The value of each contract concluded for the upstream and downstream chains of the petroleum industry is hundreds of millions of dollars, which indicates the value and, at the same time, the difficulty and risk of each operation.

Therefore, considering the characteristics of insurance securities on the one hand and the need of Iran's oil industry in the upstream and downstream sectors to cover actual and potential risks on the other hand, it seems to be a suitable solution to use insurance securities to transfer the risks of catastrophic events of this industry to the financial markets. Hence, this work aims to identify the fundamental and practical factors necessary for issuing catastrophe bonds in Iran's oil and gas industry. For this purpose, we used the Delphi method, a reliable measurement instrument for expanding new concepts and setting the direction for future-orientated research to identify influential factors and requirements needed to issue catastrophe bonds in Iran's oil and gas industry. Therefore, after the literature review and identifying primary factors, the Delphi panel chooses the experts and submits them to the designed questionnaire. After 3 rounds of Delphi, the 6 categories included 33 factors recognized as critical for issuing CAT bonds in Iran's oil and gas industry.

2. Literature review

In August 1992, Hurricane Andrew devoured Florida south of Miami, which set a new record for insured damages. Estimated damages from Andrew were about $30 billion, of which $15.5 billion was insured. This caused the bankruptcy of eleven insurance companies. In January 1994, an earthquake occurred about 20 miles northwest in the Northridge area of the San Fernando Valley. Estimated losses from the Northridge earthquake were about $30 billion, of which $12.5 billion was insured, and this caused a decrease in earthquake insurance coverage from insurance companies (United States General Accounting Office, 2002).

According to a report from the World Meteorological Organization (2014), the first decade of the 21st century was characterized by 3,496 natural disasters from floods, storms, droughts, and heat waves, of which approximately 80% were due to flooding and hurricanes. It proves natural disasters occur nearly 5 times as often as in the 1970s (Mariani and Amoruso, 2016).

The CAT bond market has expanded rapidly over the recent decade. The values of 2018 CAT bonds and outstanding bonds were $13.85 billion and $37.83 billion, respectively (Zhao and Yu, 2020). The increase in the dimensions and frequency of catastrophes and the costly damages they incur have highlighted the incapacity of the reinsurance industry to tackle and diversify risk effectively, supplying the necessary capital to cover damages. It is, therefore, clear that more than the traditional reinsurance method is required to guarantee the insurability of damages by catastrophes. Accordingly, it has become necessary to propose alternative forms to deal with the catastrophic risk (Mariani and Amoruso, 2016).

To increase the insurability capacity of insurance markets, the insurance industry and capital market participants invented insurance-linked securities (ILS) as an alternative to traditional insurance methods (United States General Accounting Office, 2002).

Catastrophe bonds are the most critical insurance-linked securities that facilitate the transfer of catastrophe risks from the insurance industry to capital markets. Catastrophe risk includes exposure to losses from natural disasters, such as hurricanes, earthquakes, and tornadoes, which are infrequent events that can cause substantial financial loss but are difficult to predict reliably. CAT bonds once considered an unusual investment for specialists, are increasingly finding their place in the mainstream of the insurance industry these days. Numerous demands from investors and a growing supply from insurance and reinsurance companies are the driving factors in the growth of this market (Zhang and Tsai, 2017). The catastrophe bond market still desires to move toward higher layers of risk (Lakdawalla and Zanjani, 2006).

CAT bonds are generally issued to cover the high layers of reinsurance protection, which is protection against events with a probability of 0.01 or less (i.e., occurring once every 100 years). Higher layers of protection are often not reinsured because insurers are concerned about the reinsurer's ability to pay, and these risks have the highest reinsurance margins, or pricing spreads above the expected loss (Smack, 2016). Most insurance companies pursue different ways to limit the magnitude of catastrophe risk they hold on their books and diversify and transfer the risk (Wu and Zhou, 2010). After that, the CAT bonds market began to grow more and more. In the first period between 1998 and 2001, an average of 1–2 billion insurance bonds were issued each year. After the September 11, 2001 terrorist attack, the issuing of CAT bonds increased to more than $2 billion per year, and in 2006, following Hurricane Katrina, the value of bond issuance increased to $4 billion annually. This market continued to proliferate through 2007 because several insurers sought diversification of coverage through the market (Hagendorff et al., 2013).

The market has grown exponentially, achieving a quick foothold after the 2008 global financial crisis with an 8% outstanding annual growth. Around $6.3 billion in catastrophe bonds and other insurance-linked securities were issued in 2014 (Zhang and Tsai, 2017).

In 2013, Tradewynd Re was issued to provide coverage for risks in the United States, Gulf of Mexico, and the Caribbean that were not previously covered by CAT bonds. For example, the bond covers energy and engineering risks, marine risks, aerospace risks, and clean-up costs from pollution (Bond, 2011).

One of the accident-prone regions of the world is the Asia-Pacific region, which is the most likely source of global expansion for CAT bonds and other ILS markets. By the end of 2018, 91 catastrophic bonds had been issued in this region worth $15 billion. In Japan, the risks associated with typhoons and earthquakes are usually transferred to the capital markets by issuing CAT bonds. So far, 75 CAT bonds worth $12.5 billion have been issued. Australia and New Zealand are the second largest regions, taking up 14 CAT bonds with about $2.6 billion in aggregate amount. Taiwan, Indonesia, and other emerging markets in Southeast Asia have also published these CAT bonds (Zhao and Yu, 2019).

Compared with other options, CAT bonds enjoy a higher spreading rate, which is attractive to potential customers. Investors also buy these securities because catastrophe risk differs considerably from the return on other investment sectors in a traditional capital market. Thus, these bonds can be regarded as "zero-beta" securities, which help them achieve a certain degree of diversification. The leading investors of CAT bonds are hedge funds, specialized catastrophe-oriented funds, mutual funds, life insurers, reinsurers, and banks (Zhao and Yu, 2019). From a sponsoring point of view, CAT bonds reduce credit risk regarding the guaranteed payment. The instant release of earthquake information facilitates the prompt availability of funds, thereby speeding up rescue/recovery activities in the damaged areas. CAT bonds can attract investors because of the higher financial return than typical security tools (Hagendorff et al., 2013).

The design of the trigger types is another critical issue of the CAT bonds. The default of the bond's principal and remaining interest payments is triggered if a catastrophic event happens and the damages exceed specific predetermined criteria. The bond may utilize an "indemnity trigger" based on actual loss to the sponsor, an "index trigger" based on industry estimates of loss, a "modeled loss trigger" based on simulations of catastrophic events to calculate losses, or a "parametric trigger" based on observable or recordable event characteristics such as the type, magnitude, and geographical region of the disaster (i.e., 80 mph Florida hurricane). A combination of triggers may also be used (Mac Minn and Richter, 2017).

Figure 1 illustrates potential critical stakeholders from an enterprise point of view, in which two pyramids demonstrate both risk flow before and capital flow after a disaster. Information flow can also be observed in the figure. The capital flow runs when victims claim their insurance coverage. The risk flow runs before the catastrophe when insurers sell their contracts.

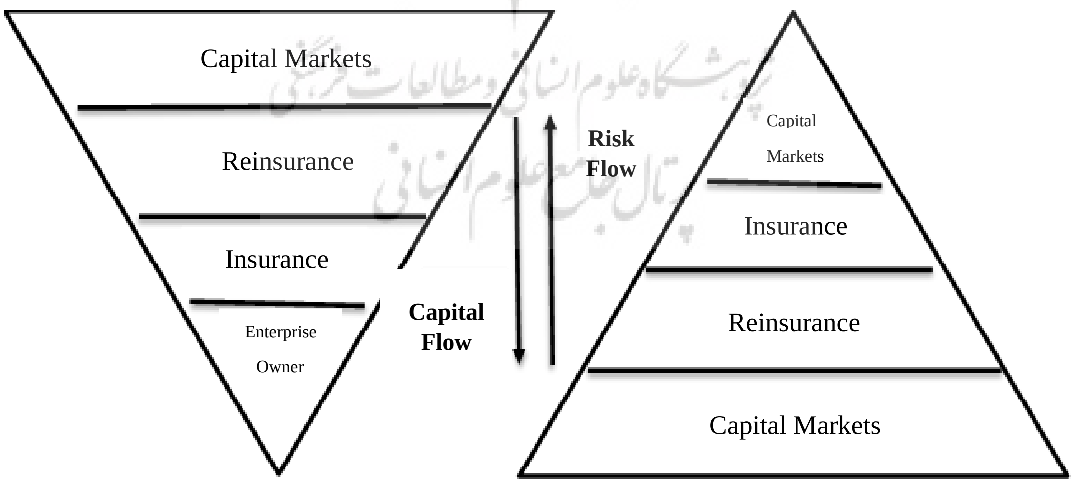

Figure 1

Potential key stakeholders when an enterprise meets a catastrophe (Wu and Zhou, 2010)

Based on the traditional and basic CAT bond model, the primary parties are the SPV that issues the CAT bond, the investors who buy insurance bonds and receive interest in return, and sponsors who insure their assets while paying insurance premiums to the SPV (Smack, 2016).

While structures vary, the main idea behind the catastrophe securitization structure of a CAT bond is that a sponsor, usually an insurer/reinsurer, enters into an alternative reinsurance contract with a special purpose vehicle (SPV). Thus, the sponsor is protected against high losses from a well-defined catastrophe up to a specific limit. To guarantee insurance coverage up to that limit, the SPV sells securities (catastrophe bonds) to investors (Zhao and Yu, 2019). Investors of CAT bonds pay a principal to buy the bonds and receive the coupon according to the contract. The critical difference between CAT bonds and common corporate bonds is that CAT bonds have trigger mechanisms, and investors may lose part or all of the principal/coupons when CAT risk hits the trigger level (Lakdawalla and Zanjani, 2006).

The capital collected by the bond sale can exclusively be used for the aims already mentioned in the reinsurance contract. Further, it merges with ad hoc funds, primarily investing in short-term titles to reduce the minimum credit risk. The trust’s assets are invested in relatively safe securities to fund the interest payments to the investors. For example, some transactions require the funds to be invested in AAA-grade U.S. Treasury securities or money market funds (Towers Watson, 2010). The investment returned on the principal and premiums from the sponsor are then used to compensate investors for using their funds and their risk assumptions (Smack, 2016).

Usually, investors receive a coupon for the risk they take, which is paid quarterly. The coupon is funded by a combination of reinsurance premiums paid by the sponsor and the proceeds of investing in the bond’s principal. The coupon rate is typically set based partly on the probability, as determined by alternative insurance risk (AIR), that the bond will lose money due to a catastrophic event. If a contractually defined trigger event occurs, part or all of the bond principal is forfeited to the ceding company; if no event occurs, the principal is returned to investors (Lakdawalla and Zanjani, 2006).

The advantages of the CAT bonds over outmoded insurance/reinsurance are the following:

- Risk is transferred to the capital market, which has significantly greater risk-bearing capacity;
- The typical setup for CAT bonds uses a single-purpose reinsurer to promote the security and liquidity of the transactions.

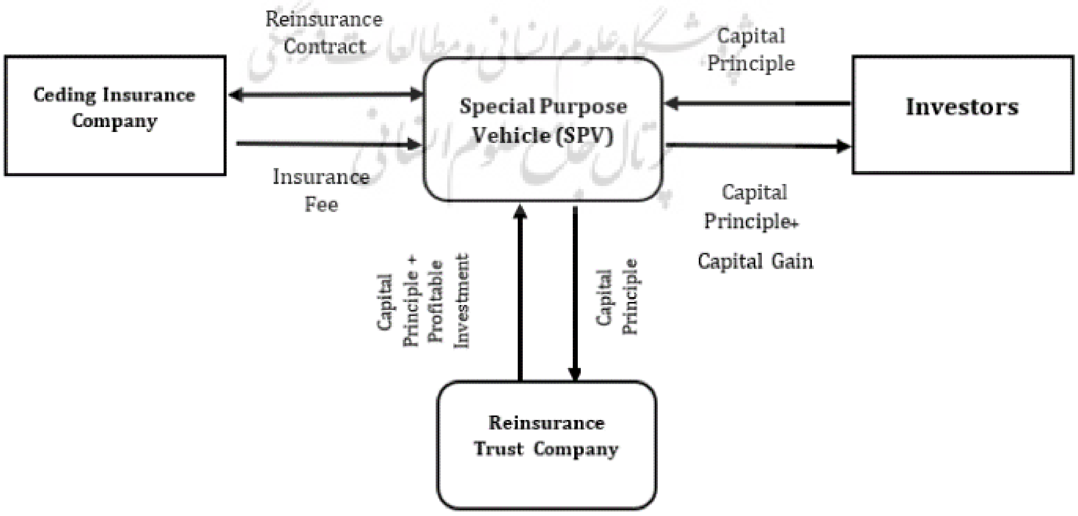

Figure 2

The model of catastrophe bonds issuance (Erwan and Marlaye, 2008)

On the other hand, according to the official statistics published by Iran's Ministry of Petroleum, the amount of recoverable liquid hydrocarbon reserves of the country (including crude oil, condensates, and gas liquids) until 2019 amounted to 160.12 billion barrels, and the recoverable natural gas reserves were about 34 TCM. Moreover, according to the statistics presented by the Organization of the Petroleum Exporting Countries (OPEC)*, after Venezuela and Saudi Arabia, Iran has the third rank of oil reserves among the member countries of this organization.

The value of contracts related to the upstream chains of the oil industry (including exploration, development, and production from the country's oil fields) and the downstream oil industry (including the establishment and management of refineries and petrochemicals, the construction and maintenance of oil and gas transmission lines, and the export of oil by tankers) reaches millions of dollars. According to the "World Oil Outlook to 2045" by OPEC, the total estimated investment required by the world's oil industry in the upstream, midstream, and downstream sectors will reach $11.8 trillion by 2045.

According to experts in the oil and gas industry, one of the main characteristics of upstream and downstream oil and gas projects is that these projects are risky, and their risks are very diverse (Askari et al., 2015). In the upstream sector, these risks include explosions, environmental pollution, injuries and damages employees or third parties may suffer and social, economic, and political risks such as nationalization and confiscation. In addition, the downstream activities also face severe risks and dangers. For example, the leakage of millions of liters of crude oil from an oil offshore drilling rig will cause environmental disasters. While the possibility of such disasters is rare, they will have a speedy and destructive effect on oil companies' activities if they happen (Ebrahimi and Jananluo, 2014). For example, On 20 April 2010, while Deepwater Horizon (an ultra-deep-water, dynamically positioned, semi-submersible offshore drilling rig owned by British Petroleum Company) was drilling at the Gulf of Mexico, a blowout caused an explosion on the rig that killed eleven crew members and ignited a fireball visible from 40 miles (64 km) away. The fire was inextinguishable, and on 22 April 2020, the Horizon sank, leaving the oil gushing from the well at the seabed and causing the largest marine oil spill in history. If the US government had wanted to compensate them for all of them, including the damage caused to the environment, the British Petroleum oil company would have gone bankrupt (Momeni and Madahi, 2015).

3. Research background

In the studies and library research, no research was found examining the requirements for issuing CAT bonds in Iran's oil and gas or other countries' oil industries. Nevertheless, several surveys have identified the essential factors for issuing CAT bonds.

The US House of Representatives (2002) published a report on the role of risk-covering financial instruments and the factors affecting their use. This report emphasizes the need to grant tax exemptions and change auditing standards related to the institution of intermediaries (SPVs). Furthermore, to promote the issuance of insurance securities, strengthening funds that buy these bonds or creating special funds that buy these bonds should be on the agenda.

In a case study on investigating the primary risk of earthquake catastrophe, Goda (2013) examined 2,000 conventional wood-frame houses in southwestern British Columbia and showed that the two factors of training market participants and collaboration among different stakeholders in the capital market were necessary for facilitating the issuance of catastrophe bonds.

* www.opec.org

In another study, Smack (2016) listed several factors for CAT bond issuance, including contract documentation, contract standardization (which reduces drafting costs), legal protection for issuing institutions (SPV), increasing protection for investors, changes in the way bond issuers are accounted for and audited, and changes in relevant laws and transparency regarding trigger conditions such as information asymmetry, adverse selection, moral hazard.

Also, Zhang and Tsai (2017) presented a general pricing formula for a CAT bond with coupon payments, which can be adapted to various assumptions for a catastrophe loss process. They argued that the existence of transparency in meeting trigger conditions as one of the most essential conditions for issuing insurance securities.

Min and Richter (2017) compared index and indemnity-based hedging as alternative design choices and stated that transparency was required in determining the trigger conditions for insurance bonds. According to this study, transparency is necessary to decide on the occurrence or nonoccurrence of the trigger conditions.

Some factors such as transparency of laws and regulations, creation of legal conditions and frameworks, creation of social conditions and frameworks, having the strategic standpoint, appropriate culture, trust and trustworthiness, reforming of insurance laws, creation of an influential intermediary institution (SPV), creation of transparency in the communication model between the parties, the definition of a reliable legal relationship between the parties and creation of an optimal relationship between the capital market and the insurance companies are operational solutions and fundamental elements to provide the infrastructure for the issuance of insurance securities and CAT bonds (Sahamian Moghadam et al ., 2019).

Goda et al. (2019) used the model to calibrate CAT-in-a-box type and intensity-based index solutions to approximate tsunami losses. According to their study, transparency regarding trigger conditions is very important because disputes regarding the realization or non-realization of trigger conditions always arise. They also believed in simplifying the processes and saw this as the basis for the participation of investment funds in purchasing these bonds.

Chang et al. (2019) argued that catastrophe bond issuance was associated with low growth due to market entry barriers, illiquidity, investor unfamiliarity, and basis risk. In another work, Zhao and Yu (2019) investigated the liquidity impact on the spread of catastrophe bonds. Based on their results, the leading investors in insurance bonds are hedge funds and specialized catastrophe-oriented funds, and these firms should be supported.

Moreover, Zhao and Yu (2020) explored the evidence from catastrophe bond markets for predicting catastrophe risk. According to this research, calculating the return on insurance securities requires a suitable platform to perform actuarial calculations. The standard statistical and actuarial calculations used in the insurance industry cannot be used due to the unique nature of insurance securities and the risks involved.

In addition to the above research, Soroush and Vakili (2020) examined the operational model for releasing insurance securities in the capital market of the Islamic Republic of Iran. Based on the results, some factors, such as the lack of rating institutions and access to software for insurance policy rate calculation and risk assessment, the lack of necessary rules and guidelines and efficiency in the capital market, and the lack of knowledge of investors about insurance securities, are the main obstacles to the release of insurance securities and CAT bonds in Iran. According to this study, developing information technology hardware and software platforms for data processing, actuarial calculations, and risk and return analysis of insurance bond issuers and establishing rating institutions and incentive policies to promote the issuance of insurance bonds for issuers by Iran's government are among the most important solutions for the issuance of CAT bonds in Iran.

After carrying out the above library studies, 33 essential factors regarding the issuance of CAT bonds were identified and classified into 7 categories based on similarities. According to identified factors based on previous research, researchers designed a questionnaire with 7 categories, including 33 factors. Table 1 lists the details of the studies and the categories and factors taken from the sources.

Table 1

Identified factors based on previous research

Item	Category	Factor	Author
1	Legislation and amendment of the rules	• Legislation related to issuing CAT bonds • Legislation related to monitoring the implementation of processes • Disambiguation of laws • Amendment of tax laws • Amendment of audit laws	Soroush and Vakili (2020) Sahamian Moghadam et al. (2019) Lisa Smack (2016)
2	Knowledge management	• Contract standardization • Contract documentation • Availability of contracts • Empowerment of insurance companies holding the training course for issuers of CAT bonds	Lisa Smack (2016) Katsuichiro Goda (2013)
3	Process management	• Long-term planning for consolidation of issuance of CAT bonds • Managing the conflicts of interest • Simplification of issuance of CAT bonds • Removing obstacles in front of issuing CAT bonds • Monitoring the bond issuance process • Designing the mechanism for dealing with disputes between investors and SPV institutions • Designing the mechanism for dealing with disputes between the SPV institutions and the sponsor • Intelligent monitoring of the SPV activities	Sahamian Moghadam et al. (2019) Goda et al. (2019) Chang et al. (2019)
4	Transparency	• Transparency related to determining trigger conditions • Transparency related to determining the occurrence or nonoccurrence of trigger conditions • Transparency related to determining valuation process damages	Goda et al. (2019) Chang et al. (2019) Zhang and Tsai (2017) Mac Min and Richter (2017) Lisa Smack (2016)

Item	Category	Factor	Author
		Transparency related to assessing the process of paying damages	
5	Creation and strengthening of software platforms	• Access to rate calculation software • Creation of rating institutions for the evaluation of insurance companies • Creation of a platform in the field of information technology for actuarial calculations • Actuarial calculations in their issuance	Soroush and Vakili (2020) Zhao and Yu (2020)
6	Supporting approaches	• Setting support incentives for domestic and foreign investors • Creating support platforms for sponsors • Setting incentives for establishing and supporting the intermediary institution (SPV)	Zhao and Yu (2019) Lisa Smack (2016) Report of House of Representatives (2002)
7	Cultivation	• Creating a culture that encourages investors to buy bonds • Creating a culture that encourages industry activists to use bonds • Creating a culture of mutual trust and cooperation between the insurance and oil industries	Sahamian Moghadam et al. (2019)

4. Research method

The Rand Think Center developed the Delphi method for the first time in 1950 in Santa Monica, California, by Norman Dalkey and Olaf Helmer, to evaluate the scientific opinions of research in complex military defense projects (Khazaei et al., 2017). This study draws on Delphi as it is considered an ideal tool for reaching consensus. An iterative questionnaire is given to an anonymous group of panelists. The Delphi process used herein is shown in Figure 3.

Delphi is acknowledged as a reliable measuring instrument that propounds new concepts and sets the stage for future research.

This alternative consensus tool is available for traditional group meetings, with the advantage of eliminating the influence of personalities of higher rank or status. It is also recommended to be used in educational departments for the last five decades (Raghav et al., 2016).

The technique extracts ideas and opinions from experts to assess the extent of agreement and tackle disagreement on an issue. It has established consensus across various subject areas (Zwolinsky et al., 2019).

The Delphi is a practical toolkit in problematic areas where the statistical model-based evidence is unavailable, or the available understanding of a problem needs to be more complete.

The strength of the Delphi process is the anonymity of panelists in the survey rounds, the controlled feedback, and iterative discussions. Anonymous survey rounds have advantages over face-to-face or group encounters in reducing dominance and group conformity. Participants feel more comfortable in providing anonymous opinions on uncertain, unsettled issues. Interpreting items may become critical in anonymous Delphi rounds and affect the consensus process. The analysis of successive iterative rounds provides a space to evaluate data for consensus and interspersed stability among the two consecutive rounds. The repetitive and interactive survey rounds are suitable for gathering qualitative information, improving the framing of the statements for panel members, and achieving consensus (Nasa et al., 2021).

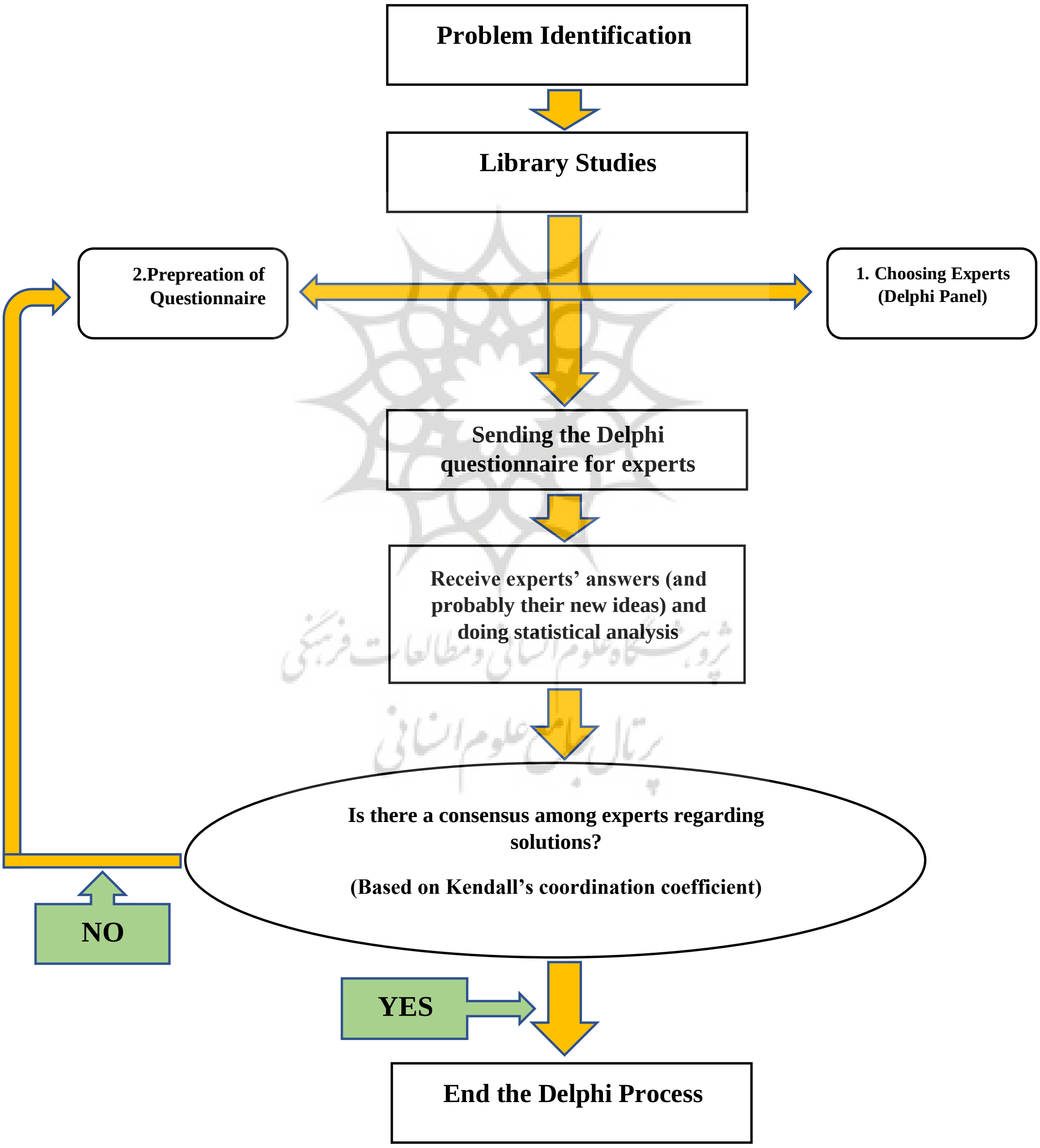

Figure 3

The Delphi process (Rasouli et al., 2014)

The Delphi method is based on one questionnaire with a Likert scale. In this way, the identified factors are designed in the form of questions, and the respondent is asked to express their opinion regarding the questions included in the questionnaire by giving points. If, after the end of each round of Delphi, the average score of all experts for a question is more than four, it means that the experts have approved the factor in question, and there is a consensus regarding its importance. Otherwise, that question will be deleted. In addition, the experts are asked to raise new factors (solutions) regarding the main research problem so these factors can be included in the questionnaire in the following rounds. Suppose the experts have yet to have any new ideas regarding the main problem of the research. In that case, Kendall's coordination coefficient will be calculated, and based on this, the Delphi panel will decide whether to continue the Delphi process or end it.

5. Data analysis

5.1. The first round of Delphi

The Delphi method is based on the consensus of experts and professionals in a particular field. Therefore, unlike other methods, the validity of the results of these methods does not depend on the number of respondents but on the validity of the participants in the research. According to reliable sources, the participation of at least seven experts in a scientific field has been suggested as a basis for the validity of this type of research. Some researchers also believe that the number of experts in the Delphi method should be over 10 people (Mashaikhi et al., 2004). Thus, the Delphi panel identified 18 experts in Tehran universities who are experts in the capital market, the insurance industry, and the oil industry, and they were requested to participate in responding to the questionnaire for a two-month period, which ends in the fall of 2022.

As mentioned in the research background and based on Table 1, after reviewing previous studies, several 7 categories, including 33 factors, were identified as essential for issuing catastrophe bonds. After drafting the questionnaires and selecting experts, the distribution of the questionnaires began in the first round of the Delphi process. After communication with the experts and initial explanations, the questionnaires were sent to them electronically. Four experts refused to complete the questionnaire despite numerous requests. Therefore, the questionnaires completed by 14 experts were subjected to statistical analysis, and the average opinions of the experts for each question and their standard deviation were calculated. According to the experts' views, of the 33 factors asked in the questionnaire, 26 were fundamental factors and requirements for issuing CAT bonds in Iran's oil industry, and 7 were rejected. In addition, the experts recorded seven new factors in the first round of the Delphi questionnaire, which were incorporated in the second-round questionnaire according to the Delphi method.

Table 2

New factors based on experts' opinions (recorded in the questionnaire)

Item	Category	New factors (recommended by experts)
1	Legislation and amendment of the rules	Needing to formulate standard rules between the oil industry, the insurance industry, and the capital market
2	Knowledge management	Holding the training course for activists of the capital market
3	Process management	Localization of papers with Iran's legal and economic situations

Item	Category	New factors (recommended by experts)
		Adapting laws and processes of CAT bonds with principles of religion
4	Transparency	CAT bonds credit rating
5	Creation and strengthening of software platforms	Strengthening hedge funds for investing in CAT bonds fields
6	Cultivation	Creating the necessary convergence between the oil industry, the insurance industry, and the capital market

5.1.1. Reliability calculations

The reliability of a questionnaire means that the results are similar, accurate, and reliable if we measure the same criteria again with the same instrument and under the same conditions (Homan, 2006). The reliability of the questionnaire tested by the obtained data was analyzed using SPSS software, and the Cronbach's alpha coefficient was calculated, indicating the data reliability. Cronbach's alpha coefficient was calculated at 0.746, demonstrating the reliability of the questionnaire.

5.2. The second round of Delphi

After completing the first Delphi round and the statistical analysis of the experts' scores on each question, the second phase questionnaire was personalized for each expert. In the new questionnaire, the experts' average scores for the questions confirmed in the first Delphi round were placed in front of each question. In addition, the expert's score was placed next to it in the first phase. In this way, the expert was asked to re-enter their score if they wished to change the question's score based on the expert's average score and consider their score in the first phase. In addition, the experts were asked to give their opinions on the new seven questions, which the experts recorded in the first round of Delphi. According to the experts' views, the number of 32 factors asked in the second stage questionnaire was confirmed, and one of the questions was rejected. Since experts did not register the new question in the second stage of the Delphi procedure, it is time to calculate Kendall's coordination coefficient.

5.2.1. Calculation of Kendall's coordination coefficient

This research used Kendall's coordination coefficient to determine the degree of agreement and consensus among panel members. Kendall's coordination coefficient shows that experts have similar criteria to judge the importance of each factor and, in this sense, agree with each other. The value of this scale is equal to one when there is complete coordination and agreement and zero when there is not complete coordination (Mirkmali and Neimour, 2014).

Therefore, the Kendall correlation coefficient for this round of Delphi was calculated at 0.133 using the formula and SPSS software calculations.

5.3. The third round of Delphi

After completing the second Delphi round and the statistical analysis of the experts' scores on each question, each expert's third-phase questionnaire was personalized. In the previous round, one question was deleted from the questionnaire, and the experts did not propose any new factors. Hence, the number of 32 questions that had received enough points were asked again by the experts.

The questionnaire of the third stage was personalized for each expert. In the new questionnaire, the experts' average scores for the questions, confirmed in the second Delphi round, were placed in front of each question. In addition, the score given by the expert in the second phase was placed next to it. In this way, the expert was asked to re-enter their score if they wished to change the question's score based on the expert's average score and consider their score in the second phase. According to the experts' opinions, all 32 factors asked in the third stage questionnaire were confirmed. In other words, the experts have considered and confirmed all the factors listed in the questionnaire as fundamental for issuing CAT bonds in the Iranian oil and gas industry. Further, since the new question was not registered in the second stage of the Delphi process, it is time to calculate Kendall's coordination coefficient.

5.3.1. Calculation of Kendall's coordination coefficient

Schmidt (1997) stated two statistical criteria for deciding whether to stop or continue a Delphi course. The first criterion is strong consensus among panel members, as determined by the value of Kendall's coordination coefficient. Suppose such consensus is absent; a constant or no significant increase in this coefficient over two consecutive rounds indicates that member agreement has not increased and the opinion survey should be discontinued (Mirkmali and Neimour, 2014). It is worth noting that for panels with more than 10 members, even minimal values of the Kendall coefficient are considered meaningful (Mashaikhi et al., 2004).

After calculations, the Kendall correlation coefficient for this round of Delphi is determined to be 0.134. Since no new factor was submitted by the experts in the third round of Delphi, all 32 factors included in the questionnaire were approved by the experts. The Kendall coordination coefficient changed slightly in the third round, compared to the second round; the Delphi process was stopped, and all 32 final factors were approved as fundamental factors for the issuance of CAT bonds in Iran's oil and gas industry.

6. Conclusions

The study was conducted to investigate and identify the factors affecting issuing of catastrophe bonds in Iran's oil and gas industry. The first step for issuing CAT bonds was to study and identify factors that should be considered basic infrastructure.

The current research was conducted using the Delphi method, one recognized and valid process for obtaining experts' opinions in various fields. Based on this method, library studies first calculated the factors affecting insurance bond release. After the initial approval by the Delphi panel members, the factors were sent to the experts in the form of a questionnaire with a Likert scale in three stages, and the experts completed the questionnaire at each stage. Finally, 6 categories, namely legislation and amendment of the rules, knowledge management, process management, transparency, creation and strengthening of software platforms, and cultivation, including 32 factors, were identified and introduced as the influential factors and requirements for issuing insurance bonds to transfer the risks of Iran's oil industry to the capital market.

The results of the present study were broadly consistent with previous related works, and most of the factors identified in earlier studies were confirmed. In addition, new factors were identified, and finally, all aspects were organized into six categories. However, the research method and its results had unique and distinct features compared to previous research. Firstly, it used the Delphi method, one of the essential methods for obtaining the expert's opinions; secondly, the requirements for the issuance of CAT bonds in Iran's oil and gas industry were examined, and a comprehensive model based on the requirements of this industry was developed: a new approach that has not received attention from other researchers. Attention to the categories and factors presented in this research can provide a relatively good view of the requirements and platforms needed to publish these bonds.

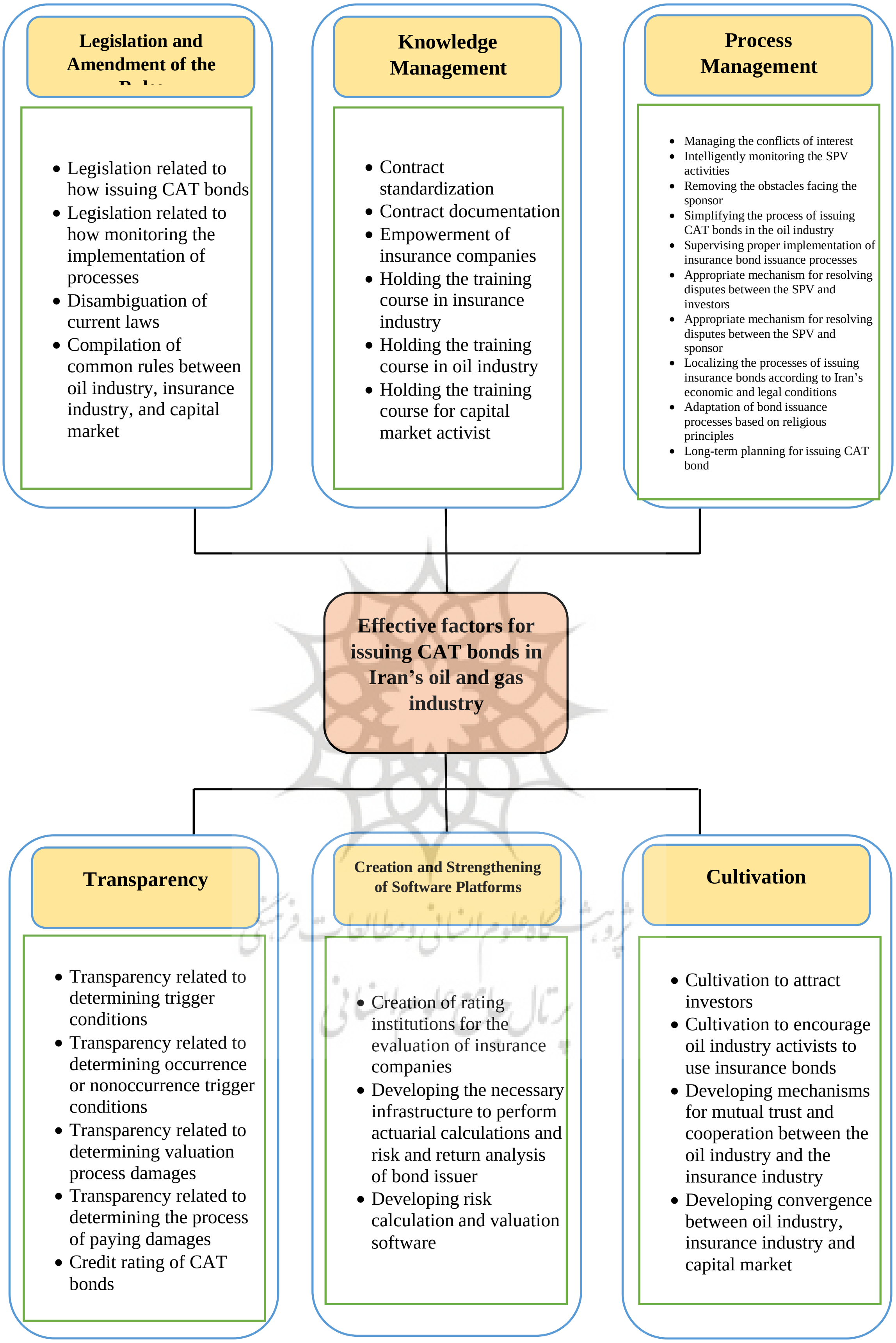

Figure 4

Influential factors for catastrophe bond issuance in Iran's oil and gas industry

Considering the mentioned factors, the institutions looking to release these bonds can take the right path in this field. In the end, the following items are recommended as future research subjects:

- Ranking the categories and factors counted in this article using ranking methods such as the AHP method;
- Localizing insurance bond issuing processes in Iran's oil and gas industry according to the economic infrastructure;
- Identifying the requirements for issuing insurance bonds to finance upstream oil and gas projects;
- Identifying the requirements for issuing insurance bonds to finance downstream oil and gas projects.

Nomenclature

AHP	Analytic hierarchy process
CAT	Catastrophe bonds
ILS	Insurance-linked securities
OPEC	The Organization of the Petroleum Exporting Countries
SPV	Special purpose vehicle

References

Alimoradi Gaghdari, S., Mehrabanpour, M., Najafimoghadam, A. (2021), Providing a model for optimal capital structure in gas refining companies and determining parameters using the AHP method, Petroleum Business Review, 5 (2), Pages 35–46.

Askari, M., Sadeghi Shahedani, M. and Siflo, S. (2015), Identification and Prioritization of Upstream Oil and Gas Project Risks in Iran Using the Risk Breakdown Structure Format and TOPSIS Technique, Economic Research and Policy Quarterly, 24 (78), Pages 70–89.

Bond, D. (2011), Making Sense of the BP Oil Spill, The Science of Catastrophe, 3 (1), Pages 70–89.

Chang, C., Wang, Y., Yu, M. (2019), Catastrophe Bond Spread and Hurricane arrival frequency, North American Journal of Economics and Finance, 24 (3), Page 1-11.

Ebrahimi, N., Jananlou, J. (2014), Management of Risk Interpretation in the Regulation of International Oil Contracts, Energy Law Studies, 2 (1), Pages 757–775.

Goda, K. (2013), Catastrophe Bond Spread and Hurricane arrival frequency, Basis Risk of Earthquake Catastrophe Bond Trigger Using Scenario-Based Versus Station Intensity–Based Approaches: A Case Study for Southwestern British Columbia, Earthquake Spectra, 29 (3), Pages 145–162.

Goda, K., Franco, G., Song, J., Radua, A. (2019) Parametric Catastrophe Bonds for Tsunamis: CAT-in-a-Box Trigger and Intensity-Based Index Trigger Methods, Earthquake Spectra, 35 (1), pages 113–136.

Hagendorff, B., Hagendorff, J., Keasey, K. (2013), The Shareholder Wealth Effects of Insurance Securitization: Preliminary Evidence from the Catastrophe Bond Market, J Finance Serv Res, 55 (3), Pages 41–63.

Homan, H. (2006), Knowing the Scientific Method in Humanities, SAMT Publication, First Edition,Tehran.

Khazaei, S., Nazemi, A., Heydari, A., Alizadeh, A., Kashani, H. (2017), A Review of Selected Methods of Future Research, Publications of the Scientific Policy Research Center of Iran, First Edition, Tehran.

Kiohos, A., Paspati, M. (2021), Alternative to Insurance Risk Transfer: Creating a catastrophe, bond for Romanian earthquakes, Bulletin of Applied Economics, 8(1), Pages 1–17.

Lakdawalla, D., Zanjani, G. (2006), Catastrophe Bonds, Reinsurance and The Optimal, North American Actuarial Journal, 21 (2), Pages 33–57.

Mac Minn, R., Richter, A. (2017), The choice of trigger in an insurance linked security: The mortality risk case, Insurance Mathematics and Economics Journal, 45 (4), Pages 50–66.

Mariani, M., Amoruso, P. (2016), The Effectiveness of Catastrophe Bonds in Portfolio Diversification, International Journal of Economics and Financial Issues, 6(4), Pages 1760–1767.

Mashaikhi, A., Farhangi, A., Momeni, M., Alidosti, S. (2004), Investigating the Key Factors Affecting the Use of Information Technology in Iran's Government Organizations with Using Delphi Method. Quarterly journal of Humanities Science, 9 (3). Pages 18–33

Michel-Kerjana, E., Morlaye, F. (2008), Extreme Events, Global Warming and Insurance-Linked Securities: How to Trigger the Tipping Point the Geneva Papers, North American Actuarial Journal, 25 (1) Pages 51–70.

Mirkamali M., Mataji Neimour, A. (2014), Identifying Factors Related to the Transfer of Education to the Workplace from the Point of View of Experts Using the Delphi method. Management Improvement Scientific-Research Journal, 8 (2), Pages 145–166.

Momeni Rad, A., Maddhahi Nasab, M. (2015), Insurance of Risks in Oil Projects, Energy Law Studies, 2 (1), Pages 1–15.

Nasa, P., Jain, R., Juneja, D., World, J. (2021), Delphi methodology in healthcare research: How to decide its appropriateness, 11(4), Pages 116–129.

Ravi Raghav P., Kumar, D., Bhardwaj, P. (2016), Experience of Delphi technique in the process of establishing consensus on core competencies, International Journal of Applied Basic Medical Research, 6(3), Pages 191–194.

Sahamian Moghadam, J., Nazari, M., Hassan Qalipour, T., Ghalibaf Asl, H. (2019), Designing a Policy Framework to Increase the Insurability Capacity by Using Catastrophic Bonds in the Insurance Industry, Monetary and Financial Economics Journal, 9 (2), Pages 23–45.

Smack, L. (2016), Catastrophe Bonds Regulating a Growing Asset Class, Risk Management and Insurance Review, 19 (1), Pages 105–125.

Surosh, A., Vakili, J. (2020), Presenting the operational model of the release of insurance securities in the capital market of the Islamic Republic of Iran, The 6th Islamic Finance Conference, Tehran.

Wu, D., Zhou, Y. (2010), Catastrophe Bond and Risk Modeling: A Review and Calibration Using Chinese Earthquake Loss Data, Human and Ecological Risk Assessment, 16 (1), Pages 510–523.

Zhang, X., Tsai, C. (2017), The Optimal Write-Down Coefficients in a Percentage for a Catastrophe Bon. North American Actuarial Journal, 32 (1), Pages 1–18.

Zhao, Y., Yu, M. (2019), Measuring the Liquidity Impact on Catastrophe Bond Spread, Pacific-Bassin Finance Journal, 56 (3), Pages 197–210.

Zwolinsky, S., Vogel, C., Griffiths, C., Hobbs, M., Ilkins, E. (2019), A Delphi study to build consensus on the definition and use of big data in obesity research**.** International Journal of Obesity, 43 (4), Pages 2573–2586.

Websites

www. gecf.org

www.mop.ir

www.opec.org