Int. J. Nonlinear Anal. Appl. In Press, 1–15
ISSN: 2008-6822 (electronic)
http://dx.doi.org/10.22075/ijnaa.2025.36859.5397

Enhancing knowledge management in financial supervision: A mathematical approaches

Abbasali Haghparast[a,*], Yasaman Maleki[a], Habib Piri[a], Reza Sotoudeh[b]

[a]Department of Accounting, Zahedan Branch, Islamic Azad University, Zahedan, Iran
[b]Department of Accounting, Nikshahr Branch, Islamic Azad University, Nikshahr, Iran

(Communicated by Javad Vahidi)

Abstract

Despite the supervision of financial and credit institutions by several regulators, evidence shows many weaknesses in the regulatory procedures for financial and credit institutions. This paper identifies and ranks the factors affecting the knowledge management implementation in the financial supervision of the Supreme Audit Court of Iran (SAC) in the banking sector. This is a qualitative paper by the grounded theory method. Data were collected by in-depth interviews with 15 experts of the SAC and the banking sector using purposive and snowball sampling methods, with open, axial, and selective coding methods to analyze the data. Findings showed that the outcomes are the most effective factor in the final model of knowledge management implementation in the financial supervision of the SAC in the banking sector, followed by strategies in the next priority. The contexts are the third priority and the background conditions and intervening conditions are ranked fourth impacts on the final model of knowledge management implementation in the financial supervision of the SAC in the banking sector with the causality having the least impact on the final model of knowledge management implementation in the financial supervision of the SAC in the banking sector. Also, the average of audit processes (strategies) and at the level of forces (intervening conditions) have gained the highest value and are the first and second priority. The least impact goes for the quality of services (causal conditions) and organization at the macro level of the bank (background conditions), ranked 37 and 38, respectively.

Keywords: implementation, knowledge management, financial supervision, the supreme audit court of Iran (SAC), banking sector
2020 MSC: 91G15, 68V30

1 Introduction

The banks' supervision is not a one-dimensional issue without the cooperation of regulatory bodies because it covers a wide range of aspects. Every supervisory institution has specific duties and responsibilities in the monitoring process [11]. In the Islamic Republic of Iran, there are several supervisory institutions to supervise financial and credit institutions, including the Central Bank, the Supreme Audit Court of Iran (SAC), the General Inspection Organization, and other institutions. Supervision in each of these institutions is strong leverage in the direction

*Corresponding author
Email addresses: medad.danesh@gmail.com (Abbasali Haghparast), maleeki.yas@gmail.com (Yasaman Maleki), hhpiri1354@gmail.com (Habib Piri), r.sotoudeh@iauzah.ac.ir (Reza Sotoudeh)

Received: January 2025 *Accepted:* March 2025

of the cohesion of the country's financial system, and proper, correct and timely use of this leverage improves the productivity of the country's financial system [21]. An especially important banking supervision factor is that an effective banking supervision system requires that banking sector auditors have a comprehensive understanding of the banks' operations and can monitor those operations [16]. However, the goals cannot be achieved without such a good understanding [23]. The Supreme Audit Court of Iran (SAC), on the one hand, must have the human, software, and hardware capacities necessary to properly assess the internal control system of banks and detect errors, and on the other hand, it must have strong monitoring tools to punish violators, not just monitor performance, submit a report and the reports even left unread in the end. In addition, the banking system should provide the SAC with correct and sufficient information to be supervised [15]. If the banks do not provide SAC with the necessary and sufficient information in a systematic way, as a supervisory authority, or send incorrect information, SAC will not have the necessary efficiency to exercise supervision. In other words, the SAC cannot verify the information received from banks to a very large extent [3]. Furthermore, the presence of numerous regulatory bodies in the supervision of the banking sector, the weaknesses in the financial supervision of the SAC in the banking sector, including lack of focus on high-risk areas, lack of control over internal controls of banks, and lack of transparency in laws related to the banking sector, including Article 4 of the General Accounting Law and other issues raised above, necessitates the development of a financial supervision framework for the SAC in the banking sector [13]. Accordingly, this paper first examines the weaknesses of the financial supervision of the SAC in the banking sector according to the SAC experts' opinions and auditors and then presents solutions to eliminate the weaknesses following the content analysis and the financial supervision framework of the SAC [4].

A look at the history of changes in the regulatory structure in different countries shows that technological advances, financial crises and economic and political developments are the main drivers and causes that sometimes prompt countries to review the structure of regulation and supervision in the financial sector. The financial sector of any country includes actors, markets, institutions and legal frameworks and regulations that, in interaction with each other, provide the possibility of flowing, directing, exchanging and allocating financial assets in the economy of that country. The important challenges facing the legislative authorities of each country, especially in the field of regulatory structure in the financial sector, is first and foremost the selection of the appropriate regulatory structure. This issue was very tangible in the issue of unauthorized institutions and their organization. With the increase in the scope of the crisis in illegal financial institutions, the importance of monitoring before the crisis became apparent, and this caused the involvement of many institutions, including the Islamic Council, the Audit Bureau, and the State Inspection Organization, so what can be found in this study is important. It should be noted that continuous and pre-crisis monitoring and solutions resulting from the results of this research can be a great help in preventing such events from happening. As mentioned, despite various regulatory bodies and regulatory structures, Iran's economy has been exposed to financial abuse over the past several years. All evidence indicates that the banking supervision system suffers inefficiency for the presence of weaknesses in the supervisory procedures. This paper focuses on the audit and financial supervision exercised by the SAC on the banking system. This paper tries to answer the question, "What is the design of the knowledge management implementation model in the financial supervision of The Supreme Audit Court of Iran (SAC) in the banking sector?"

2 Literature review

Adabesh et al. [1] monitored banks and financial institutions in terms of monetary and fiscal policy with the scale of Iranian and American law. An example of this is the political supervisory package of 2010, which neither in its fourth chapter (supervisory policies) nor in the other chapters, there is no reference to the issue of sharia supervision in compliance of the banking system with the principles of Islamic conditions and the lack of official and legal supervision body and has intensified the perception of usury in the banking system and religious suspicions about monetary and financial activities at the national, regional and international levels. Also in American law, in addition to the absence of necessary coordination between the policies adopted in US banking, the lack of necessary planning for the development of banking is one of the factors exacerbating the inefficiency of the banking system; because the absence of a clear plan to provide new banking methods and tailored to the capabilities and needs of the country and solve existing problems, will cause more backlog and more serious damage.

Seifollahi et al. [22] analyzed the effect of knowledge management and market orientation on market performance with the mediating role of open innovation in Tejarat Bank. The results showed that the variables of knowledge management (with a path coefficient of 0.37), market orientation (with a path coefficient of 0.41) and open innovation (with a path coefficient of 0.32) have a positive and significant direct effect on market performance. Also, knowledge management and market orientation, in addition to direct impact, have an indirect and significant effect on market performance through open innovation, which according to the amount obtained for VAF statistics, it was observed that

23.2% of the impact of knowledge management on market performance and 33.7% of the effect of market orientation on market performance can be explained through open innovation. Given the positive impact of knowledge management on market performance, if banks do not have the necessary competence to develop knowledge, they will not gain a knowledge-based competitive advantage. Also, market competitiveness should be increased for the importance of market orientation in achieving greater market performance. Understanding the market to understand customers' perspectives can play a role in increasing market performance. Banks need to use appropriate methods to increase their key customers' satisfaction to retain them. presented a suitable model for knowledge management in banks (case study: Parsian Bank). The statistical population included all employees of Parsian Bank Tehran branches who were selected and surveyed as a sample using cluster random sampling method, based on Morgan table. Cronbach's alpha was used to evaluate the components of the studied variables from the perspective of professors and confirmatory factor analysis and to evaluate the reliability of the questionnaires, which was calculated to be 0.83 for knowledge management and 0.81 for factors affecting knowledge management. Pearson correlation test, multiple regression and structural equation modeling method were used to test the research hypotheses. The results showed that all three human, environmental and organizational factors have a significant impact on the application of knowledge management in Parsian Bank. Also, the indirect impact factor of human and environmental factors through organizational factors on the application of knowledge management in Parsian Bank is significant. Finally, the results were discussed. examined financial and operational supervision of financial and accounting law. This is a descriptive and practical article. Our study first explains the supervision, determines its origin, and, among other problems, considering the origin of supervision, shows the problems in financial and accounting rules and regulations including obsolescence, inconsistency, multiplicity, ambiguity and inadequacy. Therefore, all these problems can be an obstacle to monitoring and achieving the goals of the legislature. It is also necessary to take seriously the role of supervision and executive guarantee.

Rozeie et al. [21] presented a favorable model of auditing and financial supervision in NAJA (General Command of the Law Enforcement of Islamic Republic of Iran). Selective sampling was performed, and the theoretical saturation method was performed to assess its validity and reliability. The research findings indicate that attracting religious, professional and experienced personnel, empowering audit staff, using appropriate tools and technology, adhering to the ethical charter and professional behavior, and sufficient financial resources are the optimal conditions for the model of audit and financial supervision process. Also, intervening conditions include rules and regulations, supervision of supervisory bodies, auditor interest and satisfaction, stakeholder expectations, professional judgment of auditors, empowerment of commanders and managers with financial rules and regulations, and acceptance of auditors as advisors to interact and coordinate with the manager. In addition, the background conditions include no work pressure and no work restrictions. Having strategic thinking, motivating employees, teamwork and synergy, total quality management, auditing program development, risk-based auditing, time management, optimal reporting and strategic auditing are model strategies and efficient and effective auditing, reducing financial irregularities and increasing discipline in work and economic, efficient and effective use of resources are the consequences of the model.

Kadkhodai et al. [15] discussed the competence of the SAC in the financial supervision of public non-governmental organizations (case study of the opinion of the specialized board of the Court of Administrative Justice regarding the supervision of the SAC on municipal accounts). This study, using library data and in an analytical and applied research, believes that based on legal sources, especially the views of the Guardian Council as an interpreter and the institution of the judge of the Constitution, as well as citing legal evidence, the Court of Accounts is limited to reviewing and auditing the credits mentioned in the national budget in financial supervision of public non-governmental organizations. However, in the absence of the Court's jurisdiction, the design of an independent financial institution as a supervisory body should be considered by the legislature.

Shams Meymandi and Alipour [23] investigated the impact of organizational structure and government financial supervision and its role in improving organizational management. The Pearson correlation coefficient test was used to evaluate the significance of the relationship between the independent variable and the dependent variable. Then, the regression analysis was used to test the hypotheses, and all hypotheses were confirmed with 95% confidence. The research findings showed that organizational structure and financial supervision affect improving organizational management.

Azar and Habashi [7] in a study entitled "Presenting an effective model for auditing the public sector of the The Supreme Audit Court of Iran (SAC) of the Islamic Republic of Iran" have stated that the main purpose of this study is to examine the public sector auditing of higher auditing institutions in twelve developed and developing countries as an effective model for the SAC of the Islamic Republic of Iran. Also, this paper proposes practical and appropriate proposals and solutions to the SAC of the Islamic Republic of Iran regarding the strengths and weaknesses of other countries according to the situation of the Islamic Republic of Iran (institutional, budgeting, Legal, accountability). The statistical population includes experts and knowledgeable experts of the Court of Accounts of the Islamic Republic

of Iran in all categories of management (senior, middle and executive). The findings of the study indicate that the experts of the SAC of the Islamic Republic of Iran think that there is a significant difference between public sector budgeting, rules and standards and procedures of public sector auditing, structure and independence of the SAC and how to audit and evaluate the performance of the SAC, how to report the (SAC) (Higher Audit Institutions and Enforcement Findings and how to handle violations by the the SAC in developed and developing countries and the Islamic Republic of Iran. Given, the difference between the above dimensions (key factors of the audit system, it can be concluded that according to the SAC experts' opinion, there is a significant difference between the audit of the public sector of the SAC of developed and developing countries and the audit of the public sector of the SAC of the Islamic Republic of Iran.

Khosravi Pour et al. [16] designed an optimal knowledge management model for regulatory agencies in Iran. Examining the goals and structure of supervisory bodies, it is clear that the knowledge management process of identifying and acquiring knowledge to reviewing and inspecting the results is not only dependent on knowledge and resources within the organization but also has a continuous and inseparable relationship with supervised organizations. Considering the necessity of converting audit and supervisory information into knowledge in the SAC, this article seeks to identify the readiness of this organization in accepting knowledge management and propose a suitable model for establishing a knowledge management system in this supervisory body. The first section surveyed and ranked the knowledge management components. The statistical population included the auditors and auditing experts of the SAC, and 234 samples were selected by simple random sampling. The second section presents an integrated and optimal model for establishing and applying knowledge management in the SAC, which emphasizes preparing a knowledge map and designing a knowledge management system, relying on a supervisory approach.

Liu et al. [17] reviewed systematic research of financial risk based on a knowledge map. Systemic financial risk is a risk that causes large losses to financial institutions or the entire financial system. Systemic risks are contagious and unpredictable, with widespread expansion and great destructive power for the economy. Using CNKI, CSSCI, and WOS databases as data sources, this paper performs visual analysis of internal systemic financial risk research from 2010 to 2020 using scientific measurements and knowledge map analysis, and using Citespace V, examines important research points, checks its evolution and analyzes its research trends, accordingly, creates a systematic integration framework to promote further development of systemic financial risk research. The findings of this paper are as follows: Systematic financial risk research is in a period of rapid development, and more attention has been paid to the literature on "risk measurement" and "macro caution" literature. Domestic research focuses on financial risks and financial supervision, among which Internet financing, supply-side reforms, and the real economy are the boundaries of systemic financial risks.

Chao et al. [10] discussed Regulatory Technology (Reg-Tech) in monitoring financial stability: classification, key methods, applications, and future orientations. Financial regulation is a basic condition for financial stability. Recently, Reg-Tech technology has become one of the main research topics in regulating financial stability. Reg-Tech aims to use artificial intelligence technologies for intelligent detection and early warning. This is a powerful tool to help inform financial regulation and high efficiency. The purpose of this study is to provide a comprehensive study of the application of intelligent technology in regulating financial stability and analyzing the goals and results of applications of this technology. We provide a framework for the application of complex networks, knowledge diagrams, machine learning, and dynamic systems in Reg-Tech. The aim is to provide a clear basis for its development and to act as a support and development base for financial stability research. Finally, we summarize the limitations and shortcomings of Reg-Tech's current advances and discuss future R&D directions.

Grodziska-Modzelewska [12] discussed the impact of the Polish Financial Supervision Authority on the bank's board of directors. The purpose of this article is to analyze the regulatory measures in place of the Polish Financial Supervision Authority in relation to the board of directors of banks operating in Poland and to show whether these measures have a real impact on their performance and internal structure. Accordingly, the proposed changes to the Polish Supervision model will be shown. This article should be a basis for discussing the real possibilities of regulators in European countries.

Anginer et al. [5] addressed bank capital regulation and risk after the global financial crisis. We review and summarize developments in banking capital regulation and banking risk following the global financial crisis. Using a new review of banking regulation and supervision that covers more than 120 economies, we show that regulatory capital has increased; however, some elements of capital regulation have been simplified. By analyzing bank-level data, we also document the importance of defining bank regulatory capital as the quality of capital in reducing bank risk. This is especially true for banks that have more authority to calculate regulatory capital ratios and are less closely monitored in the market.

Avignone et al. [6] examined centralized or decentralized banking supervision with evidence from European banks. This article analyzes the impact of the banking union on the credit risk of European banks. In particular, we examine the impact that the establishment of a single regulatory mechanism has had on the credit risk of the banks under its control compared to financial institutions that are still under the supervision of national authorities. We analyze a sample of 746 European banks in the period 2011-2018 using the difference in method. We provide empirical evidence that supervisory banks with a single supervisory mechanism reduce credit risk compared to banks supervised by national supervisors, indicating that the banking union has successfully reduced the risk of the European banking sector. Our results confirmed a set of robustness tests that support the reliability of our analysis. Our partnership highlights the benefits of centralized versus decentralized supervision, the effectiveness of the current regulatory system in Europe, and its impact on European Bank risk.

Adeoye et al. [20] examined the impact of auditing on risk assessment, auditing of banking payment systems. The results showed that the management of risk assessment, systems auditing and financial reporting by the banking industry in Nigeria limits it by 35%, 13% and 18%, respectively. The results also showed that the role of auditing by assessing risk, auditing the system and verifying financial statements in determining the cause of fraud in the banking industry in Nigeria is statistically significant.

Aknis et al. [2] examined the impact of supervision on timely lending in banks using a unique database created by the World Bank that includes more than 3,900 companies in a country. The results of this study show that fast and timely lending can reduce corruption in countries with state ownership in the banking system. in a study entitled "Changing China's banking sector as an institutional evolution" stated that policies in China's banking sector were implemented by the authorities through a politically controlled bureaucracy centered on China's central control. Officials' deep concern for the financial stability of banks has led to the adoption of international standards and banking regulations, which has intensified the supervision of such banks. Research by [8] theoretically examines the supervision of public and private bank loans in the event of unexpected financial shocks. Their model predicts that state-owned banks will provide more loans to the real sector during the crisis, compared to private banks, which will reduce lending and increase liquidity assets. They gave three reasons for this heterogeneous behavior. First, the different goals of state-owned banks, compared to their private counterparts, are not only to maximize profits according to risks but also to stabilize and promote economic recovery. Second, state-owned banks may not suffer from declining deposits because the government has more access to additional funds that are likely to help them. Finally, state-owned banks may not suffer from declining deposits due to higher credit.

Johari et al. [14] Bank Lending Channel Reaction to Financial Suppression Policies. Iran's economy has been suffering from the dominance of fiscal policies and financial repression for many years, so this issue has become one of the structural challenges of the country's economy. Banks, as one of the most important parts of macroeconomics, play an important role in the mechanism of transferring monetary policy to the real sector of the economy. Monetary policy transmission operates through various channels: the lending channel, the balance sheet channel, and the capital channel. Examining how the role of banks in monetary policy transmission is affected by government fiscal repression policies provides useful information for monetary and financial policymakers and banking activists. In this study, we tried to investigate the effect of financial repression on the monetary policy transmission through the lending channel of the country's banks. First, an indicator for the financial repression variable was defined using the PCA method, and then the relationship was estimated using the SVAR method and instantaneous response functions and using seasonal data for the period 1999- 2017. The results show that financial repression policies have a significant effect on bank lending and reduce banks' lending power. This issue, along with the negative real interest rate of bank facilities, causes a decrease in the profitability index and the loss of banks.

Bozorgi Gerdvisheh et al. [9] Efficiency Analysis of Banking Sector in Presence of Undesirable Factors Using Data Envelopment Analysis. Banks play an important role in the growth and development of any economy. A profitable banking system enhances economic stability and efficiency to mitigate the impacts of sudden macroeconomic shocks. To be more efficient and profitable, banks need to recognize the factors underpinning their performance. Accrued liabilities are one of the factors that hinder the profitability of banks. There are several methods to assess banks' profitability with their own pros and cons. Among them, data envelopment analysis (DEA) has been recommended as one of the most common approaches to evaluate different efficiencies, including cost efficiency, revenue efficiency, technical efficiency, and finally, profitability. The availability of prices/weights of inputs and outputs provides financial managers with significant information for evaluating efficiencies and assists them in decision-making and strategy development processes. This study mainly aims to analyze banks' profitability by considering accrued liabilities resulting from undesirable factors, for which relevant data were collected from 33 branches of a commercial bank in Gilan province, Iran, based on managerial and weak disposability. The results illustrated that only three branches were graded one in three dimensions of efficiency, namely technical, cost and revenue, and profitability. Besides, it was suggested that

the lack of these efficiencies was not correlated with the branches' profitability.

3 Research methods

This is an applied descriptive survey based on library resources. This research has a mixed approach and uses the data theory method as the main research method. The grounded theory or data theory method is a qualitative research method by which a theory is developed using a set of data. This paper's first section includes the data-based theorizing method. This method was invented by Strauss and Corbin and means a method that produces theory based on data. The data collected to describe the processes includes a variety of qualitative data, including observations, conversations, interviews, government documents, and the researcher's personal reflections. In this method, all content or data that is somehow related to the subject under study is a source of information. Hence, the main step is to identify data collection techniques. Presenting a data-driven theory requires simultaneous data collection and analysis. Theoretical sampling in this method means that the data is collected in a way that is useful for generating a theory. This paper develops a model using this method and during the continuous process of collecting, analyzing and classifying data through interviews. It is worth mentioning that in these interviews, the researcher sought to identify the existing challenges, benefits, cand omponents and provide a model for implementing knowledge management in the financial supervision of The Supreme Audit Court of Iran (SAC) in the banking sector. In theoretical sampling, data collection and data analysis are actions that are highly interdependent and should be performed intermittently for analysis guides data sampling. In this paper, sampling begins by first identifying the individuals who were executive and scientifically relevant to the research. It should be noted that financial and auditing experts, professors and managers with sufficient knowledge of the relevant components and executive experience or research experience were selected to interview. Also, those with the necessary characteristics in both areas were given a higher priority for the interview. Sampling continued until the data was saturated. Then, after completing the interviews, the obtained information was categorized, and then the data were re-analyzed by systematically linking the categories in a model. After designing the knowledge management implementation model in the financial supervision of the SAC in the banking sector, in the second stage of the research, to investigate the model fit and perform the necessary analyzes, the structural equation modeling technique was used using SPSS and Amos software.

In qualitative interview research, data collection stops when information about the dimensions of the research is saturated, and this occurs when the subject is complete and no new information related to the subject is obtained. With this explanation in qualitative research, sample size is synonymous with data saturation. Therefore, in the present study, the number of selected samples was equal to 15 experts of the Supreme Audit Court of Iran (SAC) with at least ten years of experience and knowledge in the research subject matter. By conducting this number of interviews, the researcher has recognized that the collected information has reached saturation point and there is no need for further interviews. Finally, the collected data were analyzed using foundation data analysis. The data and concepts studied are loaded in the coding table to select the main concepts and central categories. At this stage, using the concepts obtained from the open coding data, the researcher re-examines the data and information collected by studying and reviewing them and redistributing the data to the interviewees through direct contact and presence. The information was placed in the axial coding table with the title of component by modifying and correcting and obtaining their expert opinion and some informed experts. The axial coding step is based on the communication of categories to subcategories, which is related to the six data approaches of the foundation.

4 Research findings

4.1 Ranking the effective factors in the final model of implementing knowledge management in the financial supervision of the Supreme Audit Court of Iran (SAC) in the banking sector

After identifying and extracting the effective factors in the final model of knowledge management implementation in the financial supervision of the Supreme Audit Court of Iran (SAC) in the banking sector at this stage, first, the structural matrix of internal relations (self-interaction), stability factors (SSIM) (to determine the relationship between factors in terms of effectiveness and impact (completed by experts through a questionnaire in the appendix.) In this study, we are faced with a group decision, so to aggregate the opinions of experts, first, by convert the symbols of the SSIM matrix to zero and one in terms of rules and calculations. The arithmetic mean of the cumulative matrix views for the factors affecting the final model of knowledge management implementation in the financial supervision of the Supreme Audit Court of Iran (SAC) in the banking sector was obtained as follows.

$$r_a = \frac{J}{J-1}\left(1 - \frac{\sum S_j^2}{S^2}\right) \tag{4.1}$$

in this formula:

- J = Number of subsets of questions in the questionnaire or test
- Variance of subtest j
- Total test variance

If the calculated Cronbach's alpha is higher than 0.7, the test has an acceptable level of reliability.

4.2 Structural self-interaction matrix (SSIM)

Interpretive Structural Modeling (ISM) suggests using experts' opinions based on various management techniques, including brainstorming, nominal group techniques, and others, to develop content relationships among variables. As a result, in this study, to determine the relationships in the development of knowledge management implementation in financial oversight of the Audit Court in the banking sector, the opinions of 10 experts were utilized. Experts were asked about each pair of criteria to express their opinions on the existence of a relationship between them. Four symbols were used to indicate the nature of relationships between two criteria iii and jjj:

- **V:** If criterion iii only influences jjj.
- **A:** If both iii influences jjj and jjj influences iii.
- **X:** If only jjj influences iii.
- **O:** If no influence exists between iii and jjj.

According to Warfield's [24] guidelines, the mode of experts' opinions was used to determine the type of relationship between obstacles to tourism development.

4.3 Initial reachability matrix

The Structural Self-Interaction Matrix (SSIM) is transformed into a binary matrix known as the initial reachability matrix, containing only zeros and ones. The rules for replacing the four initial values (2, 1, -1, and 0) with zeros and ones are as follows:

- If the intersection of criteria (i,j)(i, j)(i,j) in SSIM is **V**, the corresponding cell in the reachability matrix (i,j)(i, j)(i,j) is set to 1, and (j,i)(j, i)(j,i) is set to 0.
- If the intersection of criteria (i,j)(i, j)(i,j) in SSIM is **A**, both (i,j)(i, j)(i,j) and (j,i)(j, i)(j,i) are set to 1.
- If the intersection of criteria (i,j)(i, j)(i,j) in SSIM is **X**, both (i,j)(i, j)(i,j) and (j,i)(j, i)(j,i) are set to 0.
- If the intersection of criteria (i,j)(i, j)(i,j) in SSIM is **O**, (i,j)(i, j)(i,j) is set to 0, and (j,i)(j, i)(j,i) is set to 1.

In matrix **D**, which represents the initial reachability matrix, each element $dijd_{ij}dij$ is replaced with either 0 or 1. The variable **cj** represents the implementation of knowledge management in financial oversight of the Audit Court in the banking sector.

4.4 Initial reachability matrix

The Structural Self-Interaction Matrix (SSIM) is transformed into a binary matrix known as the initial reachability matrix, containing only zeros and ones. The rules for replacing the four initial values (2, 1, -1, and 0) with zeros and ones are as follows:

- If the intersection of criteria (i,j)(i, j)(i,j) in SSIM is **V**, the corresponding cell in the reachability matrix (i,j)(i, j)(i,j) is set to 1, and (j,i)(j, i)(j,i) is set to 0.
- If the intersection of criteria (i,j)(i, j)(i,j) in SSIM is **A**, both (i,j)(i, j)(i,j) and (j,i)(j, i)(j,i) are set to 1.
- If the intersection of criteria (i,j)(i, j)(i,j) in SSIM is **X**, both (i,j)(i, j)(i,j) and (j,i)(j, i)(j,i) are set to 0.
- If the intersection of criteria (i,j)(i, j)(i,j) in SSIM is **O**, (i,j)(i, j)(i,j) is set to 0, and (j,i)(j, i)(j,i) is set to 1.

In matrix **D**, which represents the initial reachability matrix, each element $dijd_{ij}dij$ is replaced with either 0 or 1. The variable **cj** represents the implementation of knowledge management in financial oversight of the Audit Court in the banking sector.

4.5 Final reachability matrix

The final reachability matrix is obtained by considering the transitive relationships to ensure consistency with the initial reachability matrix. To achieve this, the initial matrix is raised to the power $K + 1$ until a stable state is reached ($M^K = M^{K+1}$). At this stage, some zero elements may be transformed into ones, indicated as $1 * 1$. The final reachability matrix is derived using the following formulas:

$$M = D + I \tag{4.2}$$

$$M^* = M^K = M^{K+1} \tag{4.3}$$

where **I** represents the identity matrix.

In large and complex systems, it is assumed that each element is reachable from itself. Therefore, all diagonal elements in the final system matrix must be 1. To ensure this, the identity matrix is added to the initial reachability matrix to form the final matrix. One key property of the final matrix is:

$$M^2 = M$$

Thus, the matrix is continuously raised to a power until this condition is met. The exponentiation process follows Boolean algebra rules, where:

$$1 + 1 = 1 \quad \& \quad 1 \times 1 = 1$$

4.6 Predecessor and successor sets

Each system component (criteria) has two different sets: Predecessor Set (A) and Successor or Reachability Set (R), which play an essential role in structuring the final matrix and system design.

- **Predecessor Set (A):** This includes criteria that influence or lead to a particular criterion. In other words, the criteria with a 1 in their column for a given criterion are considered its predecessors. For example, if criteria 2, 3, and 4 influence criterion 1, then these criteria form the predecessor set of criterion 1.
- **Successor Set (R):** This includes criteria influenced by a particular criterion. For instance, if criterion 1 influences criteria 2, 3, 4, and 5, then these criteria form the successor set of criterion 1.

The successor set is also referred to as the Reachability Set.

4.7 Level partitioning of criteria

After determining the reachability and predecessor sets for each criterion, level partitioning is performed. The intersection of these two sets is calculated. If the intersection set is identical to the reachability set, that criterion is assigned to the first level. These criteria are then removed, and the process is repeated for the remaining criteria to determine their levels. Once levels are identified, an ISM diagram is drawn. The level for each criterion is determined using the following formula:

$$R(c_j) \cap A(c_j), \quad \forall c_j \in C \tag{4.4}$$

where C represents the set of all criteria.

4.8 Clustering of criteria

To categorize the criteria, driving power and dependence power must be calculated from the final reachability matrix.

- **Driving power:** The number of criteria (including itself) that a particular criterion influences.
- **Dependence power:** The number of criteria that affect a particular criterion.

The MICMAC Analysis (Matrix of Cross-Impact Multiplications Applied to Classification) is used to categorize criteria into four groups:

1. **Autonomous Variables:** These have weak driving and dependence power. They are relatively disconnected from the system and have minimal interaction.
2. **Dependent Variables:** These have weak driving power but strong dependence power.
3. **Linkage Variables:** These have both strong driving and dependence power. They are highly unstable, meaning changes to these criteria influence others significantly and receive feedback from other criteria.
4. **Independent Variables (Driving Variables):** These have strong driving power but weak dependence power. A criterion with high driving power is a key variable and falls into either the independent or linkage category.

The MICMAC framework is represented as follows:

		Driving Power ↓
Region 3	Region 4	1
		2
		⋮
		$n^{-1}n^{-1}n^{-1}$
Region 2	Region 1	nnn
nnn	$n^{-1}n^{-1}n^{-1}$	2

4.9 Steps in ISM methodology

1. **Formation of SSIM (Structural Self-Interaction Matrix)**
   - Relationships between criteria are determined using symbols:
     - **V:** Criterion iii enables criterion jjj.
     - **A:** Criterion jjj enables criterion iii.
     - **X:** Both criteria enable each other.
     - **O:** No relationship exists.
2. **Formation of Initial Reachability Matrix**
   - SSIM is converted into a binary matrix by replacing symbols with 0s and 1s.
3. **Formation of Final Reachability Matrix**
   - After forming the initial matrix, the final reachability matrix is derived to ensure consistency.

i \ j	C1	C2	C3	C4	C5
C1	1	1	0	0	0
C2	0	1	1	1	0
C3	1	0	1	1	0
C4	1	0	0	1	1
C5	1	0	0	0	1

i \ j	C1	C2	C3	C4	C5	Power of influence
C1	1	1	1	1	0	4
C2	1	1	1	1	1	5
C3	1	1	1	1	1	5
C4	1	1	0	1	1	4
C5	1	1	0	0	1	3
Degree of dependency	5	5	3	4	4	

4. **Level Partitioning of Variables**
   - Each criterion's reachability and predecessor sets are identified.
   - If a criterion's reachability set equals its intersection with the predecessor set, it is assigned to the highest level.
   - The process is repeated to determine all levels.

This structured approach provides a systematic and hierarchical representation of relationships between criteria, aiding in decision-making and strategic planning.

Table 1: Matrix of aggregation of experts' opinions on the factors affecting the final model of knowledge management implementation

Title	One	Two	Three	Four	Five	Six
Intervening conditions	0.80	0.53	0.93	0.78	0.60	0.73
Contexts	0.53	0.80	0.80	0.78	0.60	0.93
Strategies	0.60	0.33	0.73	0.67	0.67	0.73
Background conditions	0.60	0.33	0.93	0.93	0.60	0.87
Causality	0.73	0.60	0.87	0.73	0.93	0.73
Outcomes	0.20	0.93	0.67	0.43	0.53	0.93

The researcher's opinion and the frequency of experts' opinions as well as the relations attracted more than 70% of experts' opinions were considered as possible relations with a value of 1 in this matrix to extract the initial access matrices of the factors affecting the final model, and the final model of knowledge management implementation in the financial supervision of the SAC in the banking sector. Other relations, which account for less than 70% of experts' opinions, were considered insignificant and accounted for zero in the initial access matrix. The table of the initial access matrix shows the dimensions and factors affecting the final model of knowledge management implementation in the financial supervision of the Supreme Audit Court of Iran (SAC) in the banking sector.

Table 2: Initial access matrix

Title	One	Two	Three	Four	Five	Six
Intervening conditions	1	0	1	1	0	1
Contexts	0	1	1	1	0	1
Strategies	0	0	1	0	0	1
Background conditions	0	0	1	1	0	1
Causality	1	0	1	1	1	1
Outcomes	0	0	0	0	0	1

In this step, the internal consistency of the factors must be established. Table 3 shows the results. The zero numbers in the access matrix that are taken the number one after the number consistency are indicated by the $*$ sign, which shows that none of the numbers in the above matrix has changed after the match.

Using the provisions of these tables, it is possible to determine the sets of acess and introduction for each of the factors affecting the final model, the final model of implementing knowledge management in the financial supervision of the Supreme Audit Court of Iran (SAC) in the banking sector. Table 4 shows the final levels of factors affecting

Table 3: Final access matrix

Title	One	Two	Three	Four	Five	Six	Influence power
Intervening conditions	1	0	1	1	0	1	4
Contexts	0	1	1	1	0	1	4
Strategies	0	0	1	0	0	1	2
Background conditions	0	0	1	1	0	1	3
Causality	1	0	1	1	1	1	5
Outcomes	0	0	0	0	0	1	1
Dependence power	2	1	5	4	1	6	

the final model of knowledge management implementation in the financial supervision of the Supreme Audit Court of Iran (SAC) in the banking sector by determining the access sets, introduction and common elements.

Table 4: Ranking the factors

Title	Access	Priority	Shared	Rank
Intervening conditions	(1,3,4,6)	(1 ,5)	(1)	Fourth
Contexts	(1,2,3,4,6)	(2)	(2)	Fourth
Strategies	(3,6)	(1,2,3,4,5)	(3)	Second
Background conditions	(3,4,6)	(1,2,4,5)	(4)	Third
Causality	(1,3,4,5,6)	(5)	(5)	Fifth
Outcomes	(6)	(1,2,3,4,5,6)	(6)	First

The diagram with the title of ISM model developed to improve the final model of knowledge management implementation in the financial supervision of the Supreme Audit Court of Iran (SAC) in the banking sector is drawn based on the ranking, so that the outcome measures, known as the first level, are placed at the first level of the diagram and similarly, the other criteria are specified at the ranking diagram. The diagram is presented in the figure. Based on the criteria, the final model of knowledge management implementation in the banking sector financial supervision by the Supreme Audit Court of Iran (SAC) is classified at five ranks.

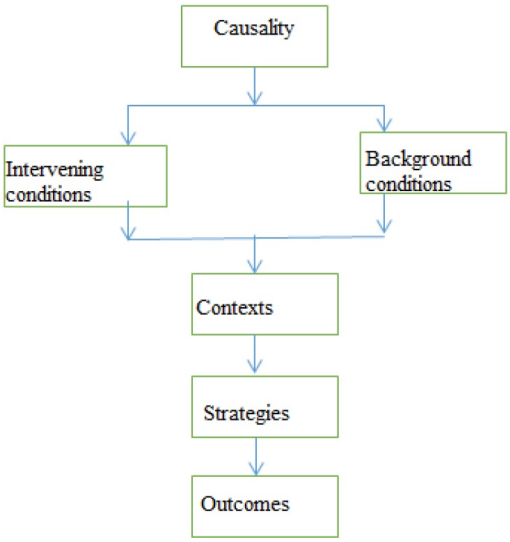

Figure 1: Factors affecting the knowledge management implementation in the banking sector financial supervision by the Supreme Audit Court of Iran (SAC)

Figure above shows that outcomes are the most effective factor in the final model of knowledge management implementation in the banking sector financial supervision by the Supreme Audit Court of Iran (SAC), with strategies as the next priority. The contexts are in the third priority and the background conditions and intervening conditions in the fourth level. Moreover, causality has the lowest impact on the final model of knowledge management implementation in the banking sector financial supervision by the Supreme Audit Court of Iran (SAC).

4.10 Ranking of effective factors in the final model of knowledge management implementation in the banking sector financial supervision by the Supreme Audit Court of Iran (SAC)

In this section, the components of effective factors in the final model of knowledge management implementation in the banking sector financial supervision by the Supreme Audit Court of Iran (SAC) identified in the previous sections are prioritized using the Ferdidman test, the results of which are reported in the table and chart below.

Table 5: Ranking the components of effective factors in the final model of knowledge management implementation

Title		Symbol	Mean ranking	Priority
Causality	Service quality	Q1	12.80	37
	Stability	Q2	15.46	28
	Integrate monitoring concepts	Q3	18.45	18
	Competitive price	Q4	14.95	30
	Personalize proposed value	Q5	16.56	24
	Advanced technology	Q6	17.68	19
	Innovation	Q7	17.48	20
	Independence of the vote of the advisory boards	Q8	15.36	29
	Personal characteristics of the auditor	Q9	14.18	35
	Customer industry knowledge	Q10	16.24	27
	Specialization in a specific field	Q11	14.21	34
	Flexibility in commission	Q12	16.75	23
	In-person training in bank branches	Q13	14.58	33
	Providing consulting services	Q14	14.89	32
Backgrounds	Cultural readiness of bank employees	Q15	16.30	25
	IT infrastructure	Q16	16.93	22
	Specialization	Q17	14.91	31
	Organization at the macro level of the bank	Q18	13.76	36
	Creating a value network to provide services	Q19	17.35	21
Intervening	At the law level	M1	16.24	26
	At the community level	M2	21.61	14
	At the level of forces	M3	24.33	2
	At the bank level	M4	23.81	4
	At the level of the SAC	M5	22.00	11
	At the level of regulatory resources	M6	21.91	12
Contexts	Informal institutions in the banking network	Q31	21.77	13
	The position of financing in banking policies	Q32	21.48	15
	Environmental constraints	Q33	22.68	10
	Knowledge and expertise of employees and managers	Q34	22.72	9
Strategies	Financial independence	R1	23.63	7
	Operational independence	R2	23.76	5
	Amend the rules	R3	21.20	16
	Audit processes	R4	24.92	1
	In-court supervision system	R5	23.02	8
Outcomes	Enhance transparency	P1	24.28	3
	Effective communication	P2	23.64	6
	Comprehensive audit	P3	21.18	17

The table above shows that the average of audit processes (strategies) and at the level of forces (intervening conditions) have the highest value and are in the first and second priority. The lowest impact was related to the quality of services (causal conditions) and organization at the macro level of the bank (background conditions), respectively, which were ranked 37 and 38, respectively. The following diagram shows the ranking of the components of the effective factors in the final model of knowledge management implementation in the banking sector financial supervision by the Supreme Audit Court of Iran (SAC) based on the average ranking.

5 Conclusion

Supervising the government's financial performance and identifying key supervisory and evaluation factors enable governments to implement fiscal and economic policies to ultimately reach economic development and welfare improvement [18]. Today, countries are greatly affected by their foreign financial situation and have called the international community, including the International Monetary Fund (IMF), the World Bank, the Organization for Economic Cooperation and Development (OECD), etc., along with domestic stakeholders. Accordingly, it is necessary to coordinate the status and model of the budgeting, financial and regulatory system of a country with the evaluable and reporting

models of other countries based on the concept of interconnectedness with the global economy. Under these requirements and subsequently by upstream laws and regulations, including Article 219 of the Fifth Development Plan Law, Article 16 of the Civil Service Management Law, Article (26) of the Law on Adding Articles to the Law on Regulating Part of Government Financial Regulations (2) Accrual Accounting System General has been established in the executive apparatus since 2016. Therefore, performance-based budgeting must be implemented following the provisions of the above-mentioned provisions and paragraphs 32 and 33 of the Supreme Leader's communication policies. Effective implementation of operational budgeting depends on an efficient financial monitoring and evaluation system [19].

The main categories around the focal phenomenon of research were formed to answer the main research questions and in the path of data analysis from selective coding (based on the results of the previous two stages of coding) as the main stage of the grounded theory. Then, following the categories validation using quantitative analysis of the relationship between the categories and themes discovered, the six categories, including pivotal category, causal factors, intervention factors, contextual factors, strategies and consequences were introduced as a comprehensive model for supervising and evaluating financial performance.

After identifying and extracting the effective factors in the final model of knowledge management implementation in the financial supervision of the Supreme Audit Court of Iran (SAC) in the banking sector at this stage, first, the structural matrix of internal relations (self-interaction), stability factors (SSIM) (to determine the relationship between factors in terms of effectiveness and impact was completed by experts through a questionnaire in the appendix. Since we are faced with a group decision in this study, so to integrate the experts' opinions, first we obtained cumulative matrix comments for the effective factors in the final model of knowledge management implementation in the financial supervision of the SAC in the banking sector by converting the symbols of the SSIM matrix to zero and one in terms of rules and calculations. Moreover, the researcher's opinion and the frequency of experts' opinions as well as the relations attracted more than 70% of experts' opinions were considered as possible relations with a value of 1 in this matrix to extract the initial access matrices of the factors affecting the final model, and the final model of knowledge management implementation in the financial supervision of the SAC in the banking sector. Other relations, which account for less than 70% of experts' opinions, were considered insignificant and account for zero in the initial access matrix. We can obtain the final levels of factors affecting the final model of knowledge management implementation in the financial supervision of the The Supreme Audit Court of Iran (SAC) in the banking sector by determining the access sets, priorities and common elements. The diagram with the title of ISM model developed to improve the final model of knowledge management implementation in the financial supervision of the Supreme Audit Court of Iran (SAC) in the banking sector is drawn based on the ranking, so that the outcome measures, known as the first level, are placed at the first level of the diagram and similarly, the other criteria are specified at the ranking diagram. Based on the criteria, the final model of knowledge management implementation in the banking sector financial supervision by the Supreme Audit Court of Iran (SAC) is classified at five ranks. The outcomes are the most effective factor in the final model of knowledge management implementation in the banking sector financial supervision by the Supreme Audit Court of Iran (SAC), with strategies as the next priority. The contexts are in the third priority and the background conditions and intervening conditions in the fourth level. Moreover, causality has the lowest impact on the final model of knowledge management implementation in the banking sector financial supervision by the Supreme Audit Court of Iran (SAC).

Another issue raised in this theme is transparency at the level of the law. One of the problems that was raised in most of the interviews was the lack of transparency in the laws and regulations. When the law is interpretable, every person with every executive body interprets it for their own benefit and to achieve their goals. Therefore, one of the preconditions of financial supervision is the existence of transparency in the formulation of laws and regulations. In the interviews conducted, some of the participants in China at this time expressed their opinion that the laws passed by the parliament are not transparent, and in some cases, this is done without expertise. Unfortunately, our laws are not clear and transparent, and various comments have caused many loopholes in our laws.

Ranking of effective factors in the final model of knowledge management implementation in the financial supervision by the Supreme Audit Court of Iran (SAC): In this section, the components of effective factors in the final model of implementing knowledge management in the financial supervision by the Supreme Audit Court of Iran (SAC) identified in the previous section were prioritized using the Ferdidman test. Audit processes (strategies) and at the level of forces (intervening conditions) gained the most value and are the first and second priority. The lowest impact was going for the quality of services (causal conditions) and organization at the macro level of the bank (contexts), respectively, which were ranked 37 and 38, respectively.

References

[1] S. Adabesh, *Supervision of banks and financial institutions from the perspective of monetary and financial policies with the Iranian-American law scale*, First Conf. Law Int. Law Politic. Sci. Human., 2021.

[2] B. Akins, Y. Dou, and J. Ng, *Corruption in bank lending: The role of timely loan loss recognition*, J. Account. Econ. **63** (2017), no. 2–3, 454–478.

[3] R. Alonso, W. Dessein, and N. Matouschek, *Organize to adapt and compete*, Ame. Econ. Assoc. J. **7** (2015), no. 2, 158–187.

[4] A. Amudo and E.L. Inanga, *Evaluation of internal control systems: a case study from Uganda*, Int. Res. J. Financ. Econ. **27** (2009), 124–144.

[5] D. Anginer, A.C. Bertay, R. Cull, A. Demirgüç-Kunt, and D.S. Mare, *Bank capital regulation and risk after the global financial crisis*, J. Financ. Stab. **74** (2024), 100891. doi: 10.1016/j.jfs.2021.100891.

[6] G. Avignone, Y. Altunbas, S. Polizzi, and A. Reghezza, *Centralised or decentralised banking supervision? Evidence from European banks*, J. Int. Money Finance **110** (2021), 102264.

[7] A. Azar and N. Habashi, *Presenting an effective model for auditing the public sector of the Supreme Audit Court of Iran (SAC) of the Islamic Republic of Iran*, Audit. Knowledge J. **17** (2017), no. 66, 5–40. [In Persian]

[8] Basel Committee on Banking Supervision, *Core Principles for Effective Banking Supervision*, Bank for International Settlements, 2012.

[9] F. Bozorgi Gerdvisheh, M. Soufi, A. Amirteimoori, and M. Homayounfar, *Efficiency analysis of banking sector in presence of undesirable factors using data envelopment analysis*, Adv. Math. Finance Appl. 8 (2023), no. 2, 589–604.

[10] X. Chao, Q. Ran, J. Chen, T. Li, Q. Qian, and D. Ergu, *Regulatory technology (Reg-Tech) in financial stability supervision: Taxonomy, key methods, applications and future directions*, Int. Rev. Financ. Anal. **80** (2022), 102023.

[11] M. Elsan, *Comparative study of the legal authority of the banking regulatory body*, 22nd Ann. Monetary Foreign Exchange Policy Conf., Tehran, 2012. [In Persian]

[12] B. Grodziska-Modzelewska, *The influence of the Polish financial supervision authority on the bank's management board*, Central Eur. Rev. Econ. Manage. (CEREM), **5** (2021), no. 1, 43–58.

[13] D. Haji Shahverdi, G. Zomordian, M. Fallah Shams Lialestani, and F. Hanifi, *Designing a system for warning the systemic banking crisis in the Iranian financial market (using Markov chains)*, Financ. Econ. **47** (2019), 135–153.

[14] F. Johari, G. Haji, N. Mehregan, and A. Sarlak, *Bank lending channel reaction to financial suppression policies*, Adv. Math. Finance Appl. **7** (2022), no. 3, 555–575.

[15] A.A. Kadkhodai and S.M. Tabatabai-Nejad, and A. Fattahi Zafarghandi, *Qualification of the state's supreme audit court in financial supervision on public non-governmental institutions*, Quart. . Public Law Knowledge **8** (2019), no. 23, 19–42. [In Persian]

[16] N. Khosravi Pour, M. Jafari, and M.R. Abdi, *Designing an optimal knowledge management model for regulatory agencies in Iran: case study: The supreme sudit court of Iran (SAC)*, Audit. Knowledge **17** (2017), no. 69, 309–328. [In Persian]

[17] F. Liu, Y. Zhang, and L. Li, *Review of systematic financial risk research based on knowledge map*, Proc. Comput. Sci. **199** (2022), 315–322.

[18] A. Masoudian, A. Jafari Samimi, A. Erfani, and I. Abu Nouri, *An analysis of the calculation of the cost of money in Iranian Banks (case study of Sepah bank branches in Semnan province)*, Financ. Econ. **13** (2019), no. 47, 1–17. [In Persian]

[19] A. Najarasl Asbforoshani, *Financial and operational supervision in financial and accounting laws*, Second Int. Conf. Challen. New Sol. Ind. Engin. Manag. Account., Damghan, 2021. [In Persian]

[20] A.J. Ojo, *The role of internal auditors in fraud prevention (case study of Nigeria bank)*, Thesis in Business Economics and Tourism, Vaasa University of Applied Sciences, Finland, 2017.

[21] M. Rozeie, *Presenting the desired model of auditing and financial supervision in NAJA*. Quart. J. Supervis. Inspect. **2020** (2020), no. 51, 33–56.

[22] N. Seifollahi and A. Hamidzadeh Arbabi, *Analysis of the effect of knowledge management and market orientation on market performance with the mediating role of open innovation (research sample: Tejarat bank)*, Strategic Manag. Organ.l Knowledge **4** (2021), no. 1, 89–122.

[23] A. Shams Meymandi and L. Alipour, *Investigating the impact of organizational structure and government financial supervision and its role in improving organizational management*, 2nd Int. Conf. Manag. Econ. Market., Tehran, 2018. [In Persian]

[24] J.N. Warfield, *Developing subsystem matrices in structural modeling*, IEEE Trans. Syst. Man Cybernet. **1** (1974), 74–80.