Ferdowsi University of Mashhad Press (FUMP)

IJAAF

IRANIAN JOURNAL OF
ACCOUNTING, AUDITING and FINANNCE

Volume 9, Issue 2, Spring 2025

Serial Number: 31

Print - ISSN: 2717-4131
Online - ISSN: 2588-6142

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Iranian Journal of Accounting, Auditing & Finance (IJAAF)

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Frequency
Quarterly

Volume 9, Number 2, Spring 2025, Serial 31

ISSN (Print): 2717-4131, ISSN (Online): 2588-6142

Editorial Office: Faculty of Economics and Administrative sciences, Ferdowsi University of Mashhad, Azadi Sq., Mashhad; IRAN; P.O. Box: 1793; Postal Code: 9177948974; Tel: +98 51 38803742; Fax: +98 51 38763852
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Structure of second page until the end of manuscript is as follow:

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recommendations based on the results (policy recommendations is necessary only in applied research and, if necessary, recommendations for future research accordant with the research limitations or how development of current research;
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Editor's Note

I am pleased to announce that the Ferdowsi University of Mashhad is publishing Iranian Journal of Accounting, Auditing & Finance (IJAAF). On behalf of the board of the IJAAF and my co-editors, I am glad to present the Volume 1, Issue 1 of the journal in December 2017; the journal will publish four issues in a year. The board includes experts in the fields of accounting, finance and auditing, all of whom have proven track records of achievement in their respective disciplines. Covering various fields of accounting, *IJAAF* publishes research papers, review papers and practitioner oriented articles that address significant issues as well as those that focus on Asia in particular. Coverage includes but is not limited to:

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Yours faithfully,
Mahdi Moradi
Editor in Chief

IJAAF; Vol. 9, No. 2, Spring 2025, Serial 31

Ferdowsi University of Mashhad

Iranian Journal of
Accounting, Auditing & Finance

Quarterly

RESEARCH ARTICLE

Game Theory-Based Analysis of the Relationship between Managers and Shareholders: An Emphasis on Information Disclosure Quality, Audit Quality and Expected Return

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How to cite this article:
Moghadam, Z. , Didar, H. , Shahbazi, K. and Ebadian, A. (2025). Game Theory-Based Analysis of the Relationship between Managers and Shareholders: An Emphasis on Information Disclosure Quality, Audit Quality and Expected Return. Iranian Journal of Accounting, Auditing and Finance, 9(2), 1-20. doi: 10.22067/ijaaf.2025.45778.1469
https://ijaaf.um.ac.ir/article_45778.html

ARTICLE INFO

Article History
Received: 2024-06-04
Accepted: 2024-12-08
Published online: 2025-04-15

Keywords:
Audit Quality, Disclosure Quality, Expected Return, Nash Bayesian Equilibrium, Signaling games

Abstract

Game theory, or interactive decision-making theory, is a mathematical framework that helps predict the outcomes of a group of interacting agents. This research aims to design and describe strategic relations between managers and shareholders through signaling games. The study investigates the consequences of choosing strategies by managers (high and low quality of information disclosure) and its relationship with the strategies chosen by shareholders (high and low expected return of shareholders) and (high and low quality of audit services) in companies with different levels of internal control establishment. The statistical population of research consists of all companies listed in the Tehran stock exchange market from 2012 to 2021. 114 companies were considered as a statistical sample of research. The study outcomes illustrate that Bayesian Nash equilibrium is established in the strategy (high-quality information disclosure and low expected return) in the strong internal control environment and the strategy (low-quality information disclosure and high expected return) in the weak internal control environment. In these strategies, neither the manager nor the shareholder has the motivation to change the strategy because their benefits will not increase by changing their strategy.

https://doi.org/10.22067/ijaaf.2025.45778.1469

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NUMBER OF REFERENCES
38

NUMBER OF FIGURES
1

NUMBER OF TABLES
3

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

Conflicts of interest are inevitable in the mutual relations of individuals, institutions, organizations, and even countries. One of the key areas where conflicts of interest arise in joint stock companies is within the relationship between managers and shareholders which can be explained by agency theory and game theory (Saffar et al., 2021). In an agency relationship, the shareholder appoints a representative (manager) to act on their behalf and delegates decision-making authority (Bansal and Vajpeyi, 2021). However, there is a fear that the manager will pursue his personal interests in the company and the interests of the shareholders will be neglected.

The transparency of financial statements and the quality of disclosure are crucial factors in ensuring the performance of managers (Assidi, 2023). They serve as practical solutions to protect the interests of shareholders. However, managers face the challenge of determining the appropriate level of disclosure quality based on the cost-benefit analysis. (Blankespoor et al., 2020). While it might seem logical for managers to provide maximum quality information regardless of the associated costs, this is not always the case. Disclosing information incurs direct (non-proprietary) and indirect (proprietary) costs for the company. (Gjergji et al., 2021). As a result, they may opt for a disclosure level lower than the maximum quality, which is not favorable for shareholders (Armstrong et al., 2011).

A crucial aspect of providing complete and reliable information lies in managers' attention to a well-designed internal control system within the organization (Hamed, 2023). By establishing and effectively implementing internal controls, managers can ensure the accuracy and validity of financial statements, thereby enhancing the overall quality of disclosure (Monteiro et al., 2021).

According to agency theory, joint-stock companies should establish effective control and monitoring mechanisms to safeguard shareholders from conflicts of interest. One such mechanism that helps reduce information asymmetry between managers and shareholders is the presence of high-quality auditing within the company (Joudi and Mansoorfar, 2020). Auditing serves as a monitoring mechanism that aligns the interests of managers and shareholders, acting as a deterrent against opportunistic behaviors by managers (Anukrithi and Zongwe, 2024). In addition to auditing, shareholders can use the Common Stock’s Expected return to protect their interests. If managers disclose low-quality information, shareholders can respond by increasing their expected return to compensate for the information risk. This, in turn, makes it more challenging for managers to secure financing, thus incentivizing them to disclose accurate and reliable information (Tran, 2022).

Game theory is a scientific discipline that employs theories and mathematical models to analyze the behavior of rational agents within strategic environments and predict their actions. In this research problem, where managers and shareholders are the key decision-makers in joint-stock companies and their actions have consequences for themselves and the other party, game theory provides a suitable framework for examination.

Given the significance of information asymmetry between managers and shareholders and the varying quality of internal controls within joint-stock companies, it is essential to model the behavior of managers and shareholders using signaling games. This research aims to demonstrate how managers make decisions regarding the disclosure of information quality within the context of joint-stock companies with different levels of internal controls. By designing the relationships between managers and shareholders as signaling games, the study explores how shareholders react to managers' actions, considering expected return strategies and the quality of audit services they receive. Additionally, the research aims to identify the optimal actions for both parties in situations of mutual dependence.

The review of theoretical and empirical studies in the research topic field shows that none of the strategic confrontation situations between the manager and the shareholder has been investigated with

the variables considered in this research. Also, in most of the studies conducted with the approach of game theory, most of the games have been examined in a static form and the form of a game with complete information (without paying attention to the problem of information asymmetry), but in this research, for the model Signaling games are used to build manager-shareholder relations; Because one of the assumptions of this type of games is the existence of an information advantage for one of the parties of the game, and considering that in joint-stock companies, the management has more information than the shareholders based on their position. Hence, game signalling methods seem favorable for analyzing the mutual relations between managers and shareholders. This study seeks to fill the void of existing studies in this field and examine the behavior of managers and shareholders in the form of signaling games. In fact, including the information asymmetry (which casts a shadow on manager-shareholder mutual relations as an influencing factor) in the modeling of manager-shareholder relations, makes the modeling of mutual relations and its results more consistent with the real world ignoring this important issue in previous research can question the accuracy of the results.

According to the mentioned contents, the following questions have been designed to examine the relationship between the manager and the shareholder in the form of signaling games:

Research Question 1:

$RQ_{1.1}$: When the manager signals low-quality information disclosure in a weak internal control environment, does the shareholder's average profit increase by choosing a high expected return compared to a low expected return?

$RQ_{1.2}$: If the shareholder's optimal strategy is to demand a high expected return and weak internal controls are present, does the manager's average benefit increase when sending a signal of low-quality information disclosure rather than high-quality information disclosure?

Research Question 2:

$RQ_{2.1}$: When the manager signals high-quality information disclosure in a strong internal control environment, does the shareholder's average profit increase by choosing a low expected return compared to a high expected return?

$RQ_{2.2}$: If the shareholder's optimal strategy is to demand a low expected return and strong internal controls are present, does the manager's average benefit increase when sending a signal of high-quality information disclosure rather than low-quality information disclosure?

Research Question 3:

$RQ_{3.1}$: When the manager signals low-quality information disclosure in a weak internal control environment, does the shareholder's average profit increase by receiving high-quality audit services compared to low-quality audit services?

$RQ_{3.2}$: If the shareholder's optimal strategy is to demand high-quality audit services and weak internal controls are present, does the manager's average benefit increase when sending a signal of low-quality information disclosure rather than high-quality information disclosure?

Research Question 4:

$RQ_{4.1}$: When the manager signals high-quality information disclosure in a strong internal control environment, does the shareholder's average profit increase by receiving low-quality audit services compared to high-quality audit services?

$RQ_{4.2}$: If the shareholder's optimal strategy is to seek low-quality audit services and strong internal controls are present, does the manager's average benefit increase when sending a signal of high-

quality information disclosure rather than low-quality information disclosure?

It is important to highlight that the sub-questions presented are formulated based on the conditions required to establish equilibrium in signaling games. These conditions will be further elaborated upon in subsequent parts of the discussion.

This paper comprises distinct sections, each serving a specific purpose and contributing to the overall analysis. A critical examination of existing scholarly works and theories about the subject matter is presented; the approach, techniques, and data collection methods employed to investigate the research questions are outlined; the results and insights derived from the analysis are presented; and the main findings are summarized.

2. Literature review

In recent years, some research has been carried out using the game theory approach in accounting and auditing. For example, Yang (2024) investigated environmental accounting information disclosure motivations in the form of bargaining games. The models of this research identify Nash Equilibrium and possible changes in strategic behavior due to adjustments within the regulatory environment. Such research implies that regulators should prescribe an integral and well-rounded approach between punitive sanctions and incentives to encourage truthful disclosure. Acknowledging the dangers of overregulation, it highlights that the regulatory framework should be dynamic and balanced to encourage compliance without stifling economic growth. Eleftheriou et al. (2023) apply game theory to model how alternative mandatory audit firm rotation regimes can affect the strategic interaction between auditee and auditor firms and analyze potential consequences on detection risk and impairment of auditor skepticism. The major results suggest that: relative to an initial state with no rotation requirement but a high probability for impaired auditor skepticism, imposing either short-term or long-term mandatory audit firm rotation will remove the threat to auditor skepticism and lead to higher audit fees and lower detection risk. They further find that imposing supplementary regulatory instruments, such as increased regulatory scrutiny of the auditee and/or auditor, can lower the detection risk and increase audit quality.

In the context of the importance of monitoring the activities of managers, Navabi Moghadam et al., (2022) showed that a lack of information about managers' operations contributes to conflicts of interest. Shareholders are unable to monitor managers' daily actions and decisions to ensure alignment with their interests. Consequently, shareholders require mechanisms to ensure managerial performance and accountability. Bahrololoum and Shamsi (2019) confirmed that implementing comprehensive disclosure approaches and ensuring transparency in financial reporting are essential factors that contribute to creating a secure environment and increasing confidence in protecting shareholders' interests.

In the following, the research related to the variables used in the design of games (the relationship between the transparency of information disclosure and the cost of capital as well as audit quality) will be discussed.

Transparency in the disclosure of financial information is a crucial factor influencing the cost of capital. When there is less transparency in information disclosure, the liquidity of stocks in the market decreases. As a result, the cost of capital increases due to higher transaction costs or reduced demand for firm securities (Tran, 2022; Johnstone, 2016; Bashirimanesh et al., 2016).

The characteristics of audit quality can influence the level of information disclosure in companies (Movahedi et al., 2019). Lee et al. (2006) propose that the quality of financial statement information results from the combined efforts of management and the audit process. Thus, the content of the

annual report is not solely audited by auditors but also influenced by them. Therefore, when managers provide inadequate information, shareholders are expected to seek greater assurance through higher-quality audits and more rigorous scrutiny of financial statements.

As a branch of applied mathematics, game theory employs mathematical models to analyze cooperation and competition among rational and intelligent entities. It aims to capture the mathematical behavior that governs strategic situations, particularly those involving conflicts of interest. Such situations arise when an individual's success depends on the strategies chosen by others. The ultimate objective of game theory is to identify the optimal strategy for the players involved.

2.1 Signaling Games

Signaling games are dynamic games that involve incomplete information and two players. In these games, one player possesses more information than the other, making it crucial for the less informed player to gain additional information. The player with superior information, known as the sender, aims to convey information to the opposing player through messages and signals, influencing their actions in line with the sender's interests. On the other hand, the less informed player, referred to as the receiver, must consider all possible states the sender can be in, along with the probabilities associated with each state. The receiver considers the possible states of the sender through the environment, which represents the set of possible states of the sender. Moreover, the receiver determines their actions based on the information received. Once the environment is established, the sender becomes aware of their exact state, known as the current or real state. The sender then takes action, ultimately determining the game's outcome for both players.

One can view the exchange between the sender and receiver as a dynamic game, allowing for analyzing their interaction and determining optimal actions and signals to be sent. This analysis enables a deeper understanding of the strategic dynamics at play and aids in identifying the most advantageous course of action for both players (Abdeli, 2013).

2.2 How to Show the Signaling Games?

Signaling games are dynamic games with incomplete information involving two players: the sender (S) and the receiver (R). The timing of the signaling game unfolds as follows:

The environment determines the type or state (t_i) of the sender. The sender can assume different states, denoted as T_S, where $T_S = \{t_1, ..., t_i\}$, and t_i belongs to T_S. However, the environment only reveals one set from T_S, specifically t_i, to the sender. Thus, the sender becomes aware of their actual type. Before the revelation of t_i, each member of T_S has a probability of occurrence, which we refer to as the probability distribution of T_S. The following properties can characterize this distribution:

$$P(ti) > 0,\ P(t1) + P(t2) + \ldots + P(Ti) = 1$$

The receiver knows the members of the T_S set, but he does not know and cannot observe which type of player the sender is (that is, which $t_i \in T_S$ the environment revealed to him). Therefore, there is asymmetric information between the sender and the receiver.

2. The sender observes its type, i.e. t_i. Then, among the different symbols that can be sent, which expresses or indicates his type, he sends the symbol q_j, which is $M= \{q_1, q_2, \ldots, q_j\}$ and $q_j \in M$, and the set of symbols sent is known to the receiver.

3. The receiver can see q_j but not ti and must infer from q_j whether it is of type t_i or not. Then

choose an action from $a_k \in A$, $A= \{a_1, \ldots, a_k\}$.

4. The utility of the sender is shown by $U^S(t_i, q_j, a_k)$ and the receiver by $U^M(t_i, q_j, a_k)$.

3. Research methodology

The current research is focused on proof theory and employs a quantitative approach. Financial data from companies' financial statements and activity reports is required to conduct the research. The data was collected using Rahavard Novin software, the Stock Exchange Organization database, and the Codal website. The collected information is then analyzed using Spss and Eviews econometric software.

The statistical population for this research is the companies admitted to the Tehran Stock Exchange, and the study period covers ten years from 2012 to 2022. The purposeful sampling method (systematic elimination) is used to select the sample companies. Companies that entered the stock market during the period had financial years ending not on March 19th, had a trading break of more than six months, were part of holding companies, leasing companies, insurance, investment, or financial intermediation companies, or had unavailable information were excluded. Ultimately, 114 companies were selected for the study.

The research methodology involves designing models to investigate the manager and shareholder relationship through signaling games. Variables such as the severity of internal control weakness, quality of information disclosure, cost of normal capital, and quality of audit were calculated for the sample companies. The companies were divided into two classes (high and low) for each variable based on quartiles. The average interests of the manager and shareholder were calculated for 16 separate cases, corresponding to the sub-questions of the research. The Mann-Whitney statistical test, a non-parametric technique for comparing means, was used to compare the average interests between the two groups. Finally, the results of this test were examined to test the three conditions of Nash Bayesian equilibrium and determine whether equilibrium was established in the designed games.

3.1 Research variables

The research variables are considered based on the interests of managers and shareholders, which are calculated as follows:

A) Interests (Utility-Consequence) of Shareholders (U^S) [1]: The firm's annual return from eight months before the beginning of the financial year to four months after it, which is considered as a criterion for the extent of the shareholders' interest (Arab Kiasari and Abdi, 2015).

b) Interests (Utility-Consequence) of Managers (U^M) [2]: The result of dividing the bonus of the board of directors by the net profit of the firm in question for each year will be published in the financial statements of the following year (Arab Kiasari and Abdi, 2015).

Weaknesses of Internal Controls: Significant weaknesses are identified from the report of independent auditors, who assess internal control weaknesses. In this research, similar to the studies conducted by Hajiha and Mohammad Hosseinnejad (2014), Saedi and Dastgir (2018), and Hajiha et al. (2017), the content analysis method is used, referring to the control instructions. Internal controls are focused on the clauses under the legal responsibilities of the firm's audit report. If the firm has at least one weakness in the internal control system, the value assigned will be 1. Otherwise, it will be zero

The Severity of Weakness in Internal Controls: In this research, the severity of weaknesses in internal controls will be determined based on their grading. Minor weaknesses will be assigned a

[1] Utility of Shareholders
[2] Utility of Managers

value of 1, major weaknesses will be assigned a value of 2, and severe weaknesses will be assigned a value of 3. If only one weakness is reported in the auditor's report, it will be considered minor. If two weaknesses are reported, they will be considered major. And if there are more than two weaknesses, they will be considered severe.

Mandatory Disclosure Quality: In this research, the disclosure index developed by Cheung et al. (2010) was utilized to measure the level of disclosure. This index consisted of 60 criteria. It is important to note that this checklist was modified to align with Iran's environmental conditions by Didar et al. (2010) in their article on the effect of corporate characteristics on the level of disclosure of companies listed on the Tehran Stock Exchange. The same modified checklist was used in this research. For each item mentioned in the checklist, a score of (1) is assigned if a firm discloses it. If a firm does not disclose a particular item, a score of (0) is assigned. If an item is deemed not applicable to a firm, it is removed from the list, following the approach outlined by Cheung et al. (2010).

The Quality of Voluntary Disclosure of Information: In this research, the measurement of the voluntary disclosure index is based on the indices proposed by Botosan (1997), which were derived from the opinions of the Jenkins Committee (Kashanipour et al., 2009). Since 2013, the board of directors' activity report has been presented in a specific format mandated by the Tehran Stock Exchange and Securities Organization. However, companies still voluntarily provide information beyond what the law requires in these reports. This voluntary disclosure is the focus of this research (Mohammadi and Sarlak, 2012).

After verifying that the information is not required according to accounting or legal standards, the indicators were determined in six general sections, comprising 71 indicators. These sections include 1) information background, 2) summary of important historical results, 3) non-financial key statistics, 4) departmental information, 5) forecast information, and 6) management discussion and analysis. The optional disclosure score is calculated by dividing the total score obtained from the six sections by the maximum possible score of 134. The mandatory and optional disclosure quality points are combined to determine the quality level of information disclosure. Values of the criterion exceeding the sample's third quartile indicate high-quality information disclosure, while values below the second quartile indicate low-quality disclosure.

Cost of Common Stock Equity: The model used to calculate the cost of common stock capital in this research is the Gordon model, derived from the following valuation model (Kaviani et al., 2018).

$$P_0 = \frac{D0(1+g)}{k-g}$$

In this model, k represents the expected return of common stock, and it can be obtained through the following equation:

$$K = r_{i,t} = (D_1)/P_0 + g$$

$$g = (S_{1400}/S_{1391})^{(1/10)} - 1$$

In this equation, D_1 represents the projected profit per share for the upcoming year, P_0 represents the share market price at the beginning of the year, and g represents the stock growth rate. This study uses the sales growth rate to measure the stock growth rate, as it is considered more stable and predictable than the profit growth rate. This is because the sales growth rate is less influenced by

accounting procedures (Mashayekhi and Farhadi, 2015).
When determining the cost of capital, values exceeding the third quartile of the sample indicate a high cost of equity, while values below the second quartile indicate a low expected return.

Audit quality: According to the research conducted by Memeshli and Karshenasan (2019), the calculation of this variable has been performed using three crucial indicators of audit quality: the auditor's reputation, the auditor's independence, and the auditor's expertise in the industry. In this study, the auditor's reputation is considered a dummy variable. Mofid Rahbar Audit Organization and Audit Institute, a large institution with a high credit and reputation grade (1), is contrasted with other audit institutes that are members of the public accountants' community. These institutions are smaller and have a lower credit and reputation grade (2).

Suppose the auditor of the owner's firm has held a leadership position in the audit organization and Mofid Institute during the research period. In that case, the virtual variable value of the auditor's reputation is considered one. Otherwise, its value is zero (Javid and Ahmadi Chegni, 2020).

Discretionary accruals have been utilized as an inverse indicator to measure auditor independence. Jones's adjusted model (1995) measures discretionary accruals in this study (Arab Kiasri and Abdi, 2014). Subsequently, the average of this variable is calculated for the companies under investigation. If the ratio exceeds the average for a particular firm, a value of zero is assigned, whereas a value of one is assigned if it is below the average (Memeshli and Karshenasan, 2019).

$$Accruals_t = a\,(Assets_{t-1}) + b\Delta sales_t + cPPE_t + dROA_t + \mu_i$$

Auditor's expertise in the industry: In this research, to calculate the auditor's expertise in a specific industry, the total assets of all employers associated with a particular audit firm within that industry are divided by the total assets of all employers in that industry (Sun and Liu, 2013; Etemadi et al., 2009). This variable solely focuses on measuring the auditor's industry-specific expertise and is independent of the size of the audited firm (Badavar Nahandi and Taghizadeh, 2013). The average of this variable is then calculated for the companies under investigation. If the ratio surpasses the average for a given firm, a value of 1 is assigned; otherwise, it is assigned as 0 (Memeshli and Karshenasan, 2019).

To simplify the interpretation of results, this research employs the factor analysis technique in the Eviews software, following the approach of Alzoubi (2018). The three audit quality criteria are converted into an index using this method. Values obtained from the factor analysis method that are greater than the third quartile of the sample indicate high audit quality, while values smaller than the second quartile indicate low audit quality.

3.2 Modeling games and finding their equilibrium

3.2.1 Designing the test related to the questions in the form of manager-shareholder signaling games

First, nature selects the type t_i (environment) for the sender (manager) from the set of possible types $T= \{t_1, ..., t_I\}$ according to the probability distribution $P(t_i)$ where for each i, $P(t_i) > 0$ and $P(t_1) + \ldots + P(t_I)= 1$.

$T = \{(t_2)$; Strong internal controls, (t_1); Weak internal controls$\}$
P (weak internal controls) > 0, P (strong internal controls) > 0
P (weak internal controls) + P (strong internal controls) = 1

The sender (manager) observes t_i and then selects q_j from the set of possible messages Q= {q_1, ..., q_J}.

Q = {(q_2); High-quality information disclosure (q_1) Low-quality of information disclosure}

In this game, the sender (manager) has four pure strategies:

S_M= AS (t_1) *AS (t_2)
= {(q_1 (t_1), q_1 (t_2)), (q_1 (t_1), q_2 (t_2)), (q_2 (t_1), q_1 (t_2)), (q_2 (t_1), q_2 (t_2))}

For example, the strategy (q_1 (t_1), q_1 (t_2)) is interpreted as if nature chooses t_1 (weak internal controls), the manager chooses q_1 (low-quality disclosure), and if t_2 (controls strong insider) to play q_1 (low disclosure quality).

The recipient (shareholder) observes q_j and not (t_i) and then chooses the move c_k from the set of possible actions: A = {c_1, ..., c_k}, in the scenarios designed in the first and second questions of the game.

A= {(c_1); High Expected return, (c_2); Low Expected return}

Also, in the scenarios designed for the third and fourth questions, shareholders will have the following set of actions:

A= {(a_1); High audit quality, (a_2); Low audit quality}

The recipient (shareholder) also has four net strategies in the first and second questions:
S_S= AR (q_1) *AR (q_2)
= {(c_1 (q_1), c_1 (q_2)), (c_1 (q_1), c_2 (q_2)), (c_2 (q_1), c_1 (q_2)), (c_2 (q_1), c_2 (q_2))}

The shareholder strategies in the third and fourth questions are:
= {(a_1 (q_1), a_1 (q_2)), (a_1 (q_1), a_2 (q_2)), (a_2 (q_1), a_1 (q_2)), (a_2 (q_1), a_2 (q_2))}

For example, (c_1 (q_1), c_1 (q_2)) means that if the manager chooses q_1 (low-quality of information disclosure), the shareholder chooses c_1 (high expected return), and if q_2 (high-quality of information disclosure), play c_1 (high expected return).

4. Utilities are determined by U^S (t_i, q_j, c_k) and U^M (t_i, q_j, c_k). These functions can be displayed in the form of the manager's and shareholder's income matrix in Table 1.

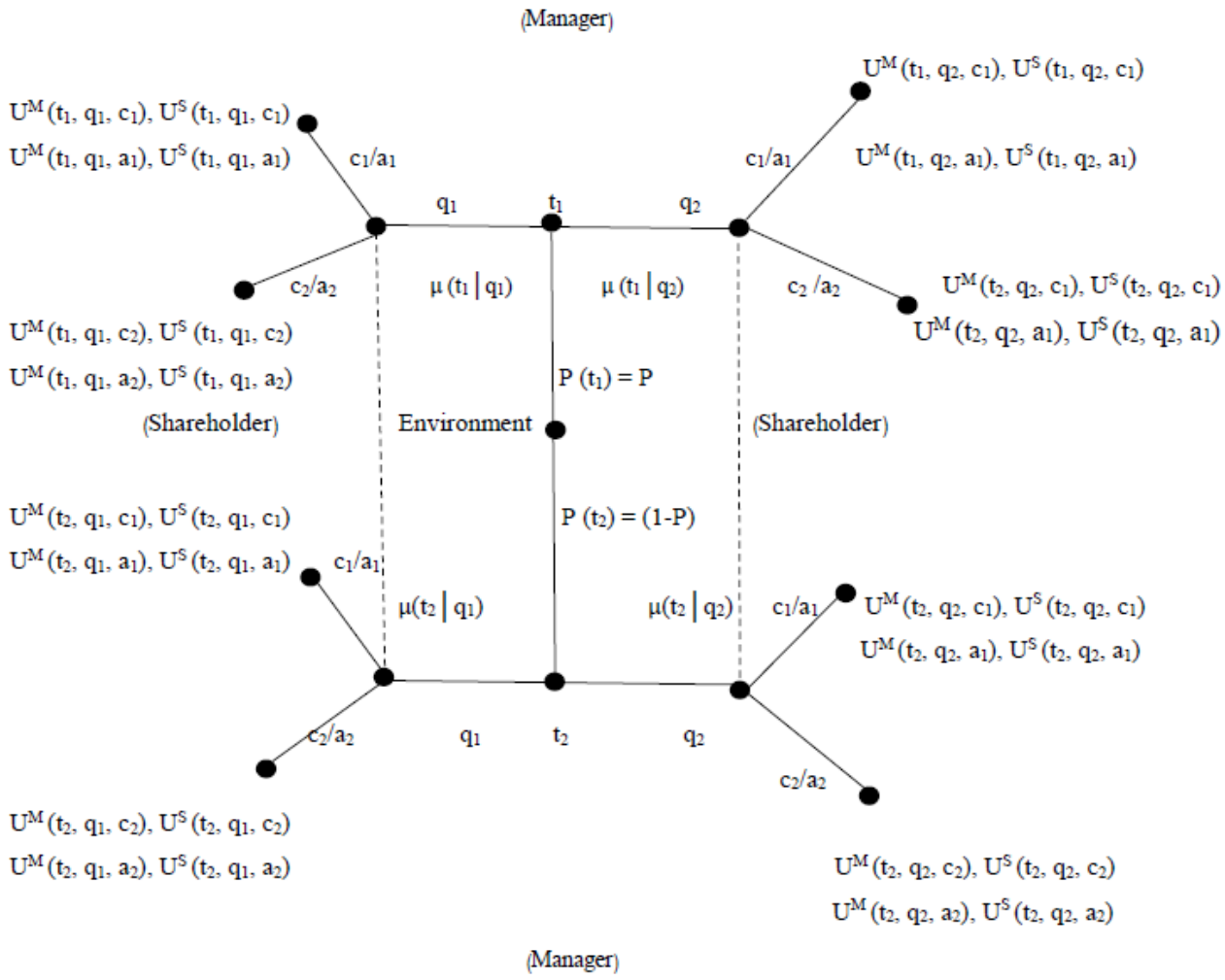

Figure 1: The quality of internal controls is determined by the environment, which can be categorized as weak (t_1) or strong (t_2) with probabilities P (t_1) and P (t_2) respectively. The manager is certain about each environment and communicates this information to the shareholder using the conditional probability (Ti | Qj) μ; (Ti= t_1, t_2, Qj= q_1, q_2). However, the shareholder cannot definitively determine their state based on the received signals, as depicted by the dotted line.

Source: research findings

Table 1. Manager's and Shareholder's Income Matrix

	Low expected return	**High expected return**
Low quality of information disclosure	$U^M(t_i,q_1,c_1)$, $U^S(t_i,q_1,c_1)$ $U^M(t_i,q_1,a_1)$, $U^S(t_i,q_1,a_1)$	$U^M(t_i,q_1,c_2)$, $U^S(t_i,q_1,c_2)$ $U^M(t_i,q_1,a_2)$, $U^S(t_i,q_1,a_2)$
High quality of information disclosure	$U^M(t_i,q_2,c_1)$, $U^S(t_i,q_2,c_1)$ $U^M(t_i,q_2,a_1)$, $U^S(t_i,q_2,a_1)$	$U^M(t_i,q_2,c_2)$, $U^S(t_i,q_2,c_2)$ $U^M(t_i,q_2,a_2)$, $U^S(t_i,q_2,a_2)$

Weak/ Strong internal controls (T_I, i= {1, 2})

For example, U^S (t_1, q_1, c_1) is the shareholder's income in the case that the environment is weak internal controls (t_1), the manager chooses the strategy of low-quality information disclosure, and the shareholder chooses the strategy of high-expected return (c_1).

Figure 1: The quality of internal controls is determined by the environment, which can be categorized as weak (t_1) or strong (t_2) with probabilities P (t_1) and P (t_2) respectively. The manager is certain about each environment and communicates this information to the shareholder using the conditional probability (Ti | Qj) μ; (Ti= t_1, t_2, Qj= q_1, q_2). However, the shareholder cannot definitively determine their state based on the received signals, as depicted by the dotted line.

Source: research findings

3.2.2 Perfect bayesian equilibrium in signaling games

To achieve a complete Bayesian equilibrium in a signaling game, it is essential to satisfy conditions 1 to 3, which will be explained below. In the signaling game, the sender (manager) completely knows the game's background. This means that when the environment determines their type, they are fully aware of the decision node or information set they are in. Consequently, a message or signal is selected within a single information set for the sender.

Therefore, the sender does not need to adhere to condition 1 since they have certainty about their information set. Conversely, the receiver (shareholder) can observe and receive the sender's message but cannot perceive the sender's type directly. As a result, the receiver's (shareholder's) action choice takes place within a non-singular information set, and condition 1 applies to the receiver. The receiver needs to satisfy condition 1, as they lack complete knowledge of the sender's type (Abdeli, 2013).

Condition 1: Once the receiver receives the symbol q_j from the set of symbols Q, where $q_j \in Q$, they must form a belief regarding the potential type of the sender associated with that particular symbol. This belief is shown by the probability distribution $\Sigma\mu$ ($t_i \mid q_j$), which ($ti \mid q_j$) >= 0 $\forall ti \in T$ and indicates the probability of t_i with sign q_j:

$$\sum_{ti \in t} \boldsymbol{\mu(ti|qj) = 1}$$

The receiver's belief when he receives the message q_1 is obtained as follows:

$$P= \mu (t_1 \mid q_1)= \frac{P(q1|t1)*P(t1)}{P(q1|t1)*P(t1)+P(q1|t2)*P(t2)}$$

$$(1\text{-}P) = \mu (t_2 \mid q_1) = 1\text{-} \mu (t_1 \mid q_1)$$

And the receiver's belief when he receives the message q_2 is calculated as follows:

$$Q = \mu (t_1 \mid q_2)= \frac{P(mq2|t1)*P(t1)}{P(q2|t1)*P(t1)+P(q2|t2)*P(t2)}$$

$$(1\text{-}q) = \mu (t_2 \mid q_2) = 1\text{-} \mu (t_1 \mid q_2)$$

After the receiver receives the signal and forms his belief, his optimal action must be determined. Condition 2 specifies his optimal action:

Condition 2 for the receiver: For each signal it receives, denoted as $q_j \in M$, the receiver must consider the belief formed about the sender's type associated with that particular signal (as per condition 1). Based on this belief, the receiver should choose the action that maximizes their expected outcome. This optimal action is represented as $a^*(q_j)$. In essence, $a^*(q_j)$ is the solution to the following optimization problem:

$$\text{Max} \sum_{ak \in A \ ti \in T} \boldsymbol{\mu(ti|qj)UR(ti.qj.ak)}$$

Condition 2 for the sender: the sender can choose and transmit different messages to the receiver based on their type. However, considering the receiver's reaction by condition 2, which is determined by the receiver's strategy ($a^*(q_j)$), the sender must strategically select a message that maximizes their expected outcome. In other words, $q_j^*(t_i)$ is the following optimization solution:

$$MAX_{qj \in q} U_S(t_i, q_j, a^*(q_j))$$

Condition 3: In the states where the optimal message is q_j (represented as $q^*(t_i) = q_j$), for every $t_i \in T_j$ in the information set corresponding to q_j, the receiver's belief is determined through the application of Bayes' law and the sender's strategy:

$$\mu(t_i \mid q_i) = \frac{P(ti)}{\sum_{ti \in Ti} P(ti)}$$

Definition of complete Bayesian equilibrium: The pure strategy in a signaling game is the combination of strategies $q^*(t_i)$ and $a^*(q_j)$ as well as the belief $\mu(t_i \mid q_j)$ that satisfies conditions 1 to 3 it does (Gibbons, 1958).

Because the conditions for establishing equilibrium have been included in the design of the research questions, a positive answer to the sub-questions means that the conditions for equilibrium have been established.

4. Research findings

4.1 Descriptive statistics of research variables

To provide comprehensive answers to the research questions, the statistics of the variables related to information disclosure quality, audit quality, and the Cost of common stock capital are categorized into low and high groups based on quartiles. The descriptive statistics of these research variables lead to eight distinct scenarios, as depicted in diagram 1. These scenarios are classified based on the manager and shareholder's interests and desirability. The outcomes of these scenarios are presented in Table 2, showcasing the analysis results. It is worth noting that the number of observations varies across different cases due to the separation of information disclosure quality levels, audit quality, and the cost of common stock capital. This differentiation allows for a more precise examination of the relationships between these variables in each context.

In all combinations, it is observed that more than 50% of managers and shareholders have lower interests than the average. The standard deviation provides insight into the extent of deviation from the average for each variable. For instance, in a specific case where the environment exhibits strong internal controls, the manager discloses high-quality information, and the shareholder imposes a low expected return on the manager (t_2, q_2, c_2), the standard deviation for shareholder interests is calculated to be 2.78.

Descriptive statistics also reveal interesting patterns. Over 18 years, firms' managers tend to disclose low-quality information in an environment characterized by weak internal controls. In response, shareholders react by imposing a high cost of equities. However, in the 46 years of the firm's existence, despite managers disclosing low-quality information in a weak internal controls environment, shareholders fail to correctly interpret the signals and form their beliefs inaccurately. Consequently, despite the low-quality information disclosure, they impose a low expected return on the managers.

Furthermore, analyzing the combination of strategy (t_2, q_2, a_2) reveals that the minimum and maximum benefits obtained are zero and 3% for managers, respectively, indicating a potential loss

of 56% and a remarkable return of 800% for shareholders. This particular situation provides a rich dataset for analysis.

Table 2. Descriptive statistics of the variables related To the research questions

	question	variable/quantity	Mean	Median	Min	Max	standard deviation	Number of observations
Question 1	Sub-question1-1	$U^{S}_{t1,q1,c1}$	3.839	1.288	-0.457	18.387	5.755	18
		$U^{S}_{t1,q1,c2}$	0.675	0.091	-0.644	16.600	2.665	46
	Sub-question 1-2	$U^{Q}_{t1,q1,c1}$	0.003	0.001	0.000	0.021	0.005	18
		$U^{Q}_{t1,q2,c2}$	0.002	0.000	0.000	0.022	0.005	30
Question 2	Sub-question 2-1	$U^{S}_{t2,q2,c2}$	2.595	1.689	-0.480	14.234	2.787	45
		$U^{S}_{t2,q2,c1}$	0.155	0.062	-0.482	3.965	0.765	31
	Sub-question 2-2	$U^{m}_{t2,q2,c2}$	0.072	0.003	0.000	0.706	0.165	45
		$U^{m}_{t2,q1,c1}$	0.009	0.001	0.000	0.048	0.013	46
Question 3	Sub-question 3-1	$U^{S}_{t1,q1,a1}$	1.180	0.333	-0.457	11.563	2.890	20
		$U^{S}_{t1,q1,a2}$	1.131	0.147	-0.644	8.594	2.639	22
	Sub-question 3-2	$U^{m}_{t1,q1,a1}$	0.023	0.002	0.000	0.323	0.071	20
		$U^{m}_{t1,q2,a2}$	0.005	0.002	0.000	0.022	0.007	15
Question 4	Sub-question 4-1	$U^{S}_{t2,q2,a2}$	1.399	0.435	-0.569	8.795	2.053	70
		$U^{S}_{t2,q2,a1}$	0.926	0.189	-0.586	6.506	1.787	24
	Sub-question 4-2	$U^{m}_{t2,q2,a2}$	0.003	0.000	0.000	0.037	0.006	70
		$U^{m}_{t2,q1,a1}$	0.006	0.000	0.000	0.031	0.009	20

Source: Research findings

4.2 The results of inferential statistics

First, the secondary questions must be examined to establish a foundation for analyzing the main research questions. In this regard, the means of the two groups were compared using the Mann-Whitney test. This test was chosen because the results of the Kolmogorov-Smirnov test indicated that the data deviated significantly from normality, with p-values less than 5%. The interests of the two key actors, managers and shareholders, were evaluated based on the percentage of the manager's bonus and the percentage of annual return on shares for the shareholders. These research questions were subjected to the Mann-Whitney test, and the results are presented in Table 3.

4.3 Examining the research sub-questions

4.3.1 Sub-question test (1-1)

In this question, the null hypothesis (H_0) states that if a manager sends a signal of low-quality information disclosure in an environment of weak internal controls, the average benefit of the shareholder will be the same for both high and low-cost capital strategies. The probability value of the Z statistic was calculated as 0.004, which is less than the significance level of 0.05. Hence, we reject the assumption of equal average shareholder interests.

Based on the average scores obtained from the test (43 and 27.93, respectively), we can claim that if the manager chooses to disclose low-quality information in a weak internal controls environment, shareholders will have higher average benefits when they choose the high expected return strategy compared to the low expected return strategy. Therefore, the answer to the first sub-question is affirmative.

Table 3. Results of inferential statistics related to research questions

	Question	Strategy combination	Number of observations	Total of ranks	Average of ratings	Mann-Whitney	z statistic	prob	Results
Question 1	Sub-question1-1	$U^{S}_{t1,q1,c1}$	17	731	43.00	204.000	-2.896	0.004	confirmed
		$U^{S}_{t1,q1,c2}$	46	1285	27.93				
	Sub-question 1-2	$U^{m}_{t1,q1,c1}$	18	552	30.67	159.000	-2.640	0.008	confirmed
		$U^{m}_{t1,q2,c2}$	30	624	20.80				
Question 2	Sub-question 2-1	$U^{S}_{t2,q2,c2}$	45	2260	50.22	170.000	-5.575	0.0001	confirmed
		$U^{S}_{t2,q2,c1}$	31	666	21.48				
	Sub-question 2-2	$U^{m}_{t2,q2,c2}$	28	1229	43.89	465.000	-2.018	0.044	confirmed
		$U^{m}_{t2,q1,c1}$	46	1546	33.61				
Question 3	Sub-question 3-1	$U^{S}_{t1,q1,a1}$	17	358	21.06	169.000	-0.510	0.624	rejected
		$U^{S}_{t1,q1,a2}$	22	422	19.18				
	Sub-question 3-2	$U^{m}_{t1,q1,a1}$	20	373	18.65	137.000	-0.435	0.681	rejected
		$U^{m}_{t1,q2,a2}$	15	257	17.13				
Question 4	Sub-question 4-1	$U^{S}_{t2,q2,a2}$	70	3443	49.19	722.000	-1.023	0.306	rejected
		$U^{S}_{t2,q2,a1}$	24	1022	42.58				
	Sub-question 4-2	$U^{m}_{t2,q2,a2}$	70	3155	45.07	670.000	-0.304	0.761	rejected
		$U^{m}_{t2,q1,a1}$	20	940	47.00				

Source: Research findings

4.3.2 Sub-question test (1-2)

In this question, the null hypothesis (H_0) states that in an environment of weak internal controls, the average benefit of the manager will be the same if they send a signal of low-quality information disclosure and the shareholder reacts with a high expected return strategy, compared to when the manager chooses to disclose high-quality information and the shareholder imposes a low expected return.

The probability value of the Z statistic was calculated as 0.008, which is less than the significance level of 0.05. Therefore, we reject the assumption of equal average manager interests.

Considering the average scores obtained from the test (30.67 and 20.80, respectively), we can claim that if the manager opts for low-quality information disclosure in a weak internal controls environment. If the shareholder imposes a high expected return strategy, the manager's average benefits will be higher than when they choose high-quality information disclosure. The shareholder imposes a low expected return. Therefore, the answer to the second sub-question is also affirmative.

The positive answer to sub-questions (1-1) and (1-2) confirms that the equilibrium is established at point (t_1, q_1, c_1). If weak internal controls are established in the environment, the manager will reach an equilibrium by signalling low-quality information disclosure and the shareholder with a high expected return.

4.3.3 Sub-question test (2-1)

In this question, the null hypothesis (H_0) states that if the manager sends a signal of high-quality information disclosure in an environment of strong internal controls, the average benefit of the shareholder will be the same regardless of their chosen strategy - high or low expected return.

The probability value of the Z statistic was calculated as 0.0001, which is less than the significance level of 0.05. Therefore, we reject the assumption of equal average shareholder interests.

Considering the average scores obtained from the test (50.22 and 21.48, respectively), we can claim that if the manager chooses high-quality information disclosure in a strong internal controls environment, the average benefits of shareholders will be higher when they choose the low expected return strategy compared to the high expected return strategy. Therefore, the answer to the third sub-question is also affirmative.

4.3.4 Sub-question test (2-2)

In this question, the null hypothesis (H_0) states that in an environment of strong internal controls, the average benefit of the manager will be the same if he sends a signal of high-quality information disclosure and the shareholder reacts with a low expected return strategy, compared to the scenario where the manager chooses low-quality information disclosure and the shareholder imposes a high expected return.

The probability value of the Z statistic was calculated as 0.044, which is less than the significance level of 0.05. Therefore, we reject the assumption of equal average interests of the manager.

Considering the average scores obtained from the test (43.89 and 33.61, respectively), we can claim that if the manager chooses high-quality information disclosure in a strong internal controls environment. Suppose the shareholder imposes a low expected return. In that case, the manager's average benefits will be higher than when the manager chooses low-quality information disclosure in the same environment. The shareholder imposes a high expected return. Therefore, the answer to the fourth sub-question is also affirmative.

The positive answer to sub-questions (2-1) and (2-2) confirms that the equilibrium is established at point (t_2, q_2, c_2).

4.3.5 Sub-question test (3-1)

In this question, we conducted a hypothesis test to determine if weak internal controls and low-quality information disclosure by the manager have an equal average benefit for shareholders in high and low audit services quality strategies.

The obtained probability value of the Z statistic was 0.624, which is above the significance level of 0.05. Therefore, we do not have enough evidence to reject the null hypothesis that both strategies' average shareholder interests are equal.

Furthermore, additional analysis shows that there is no statistically significant difference in the average shareholder interest between the high audit quality strategy (U^S t_1, q_1, a_1) and the low audit quality strategy (U^S t1, q1, a2) when the manager employs a high-quality strategy of information

disclosure.

According to the best response function, the average ratings for the strategies are 21.06 and 19.18, respectively. However, in the studied sample, this difference was not found to be statistically significant. Therefore, the answer to the fifth sub-question is negative.

4.3.6 Sub-question test (3-2)

In this question, we are examining the null hypothesis (H_0) that the average benefit to the manager, under weak internal controls, is the same when he discloses low-quality information and the shareholder responds with a high-quality audit services strategy, compared to when the manager discloses high-quality information. The shareholder imposes a low-quality audit services strategy.

The obtained probability value of the Z statistic is 0.681, greater than the significance level of 0.05. As a result, we do not have sufficient evidence to reject the assumption of equality in the manager's average interests.

The average scores obtained from the test are 18.65 and 17.13 for the respective scenarios. This suggests that even though the manager chooses low-quality information disclosure in an environment of weak internal controls, and the shareholder selects a high-quality audit services strategy, the average benefits to the manager will be higher compared to when the manager chooses high-quality information disclosure and the shareholder receives a lower quality of audit services. However, it is important to note that the difference in the average benefits between the two groups is not statistically significant. Therefore, the answer to the sixth sub-question is negative.

The negative answer to sub-questions (3-1) and (3-2) confirms that the equilibrium is not established at point (t_1, q_1, a_1).

4.3.7 Sub-question test (4-1)

In this question, we are testing the null hypothesis (H_0) that if the manager discloses high-quality information in an environment of strong internal controls, the average benefit to the shareholder will be the same for both high and low-audit service quality strategies.

The obtained probability value of the Z statistic is 0.306, greater than the significance level of 0.05. Thus, we do not have enough evidence to reject the assumption of equality in the average shareholder interests.

When examining the average shareholder interest in each strategy, namely high audit quality (U^S t_2, q_2, a_1) and low (U^S t_2, q_2, a_2), there is no significant difference if the manager chooses high-quality information disclosure. In the studied sample, the average ratings obtained are 49.19 and 42.58, respectively, but the difference is not statistically significant. Therefore, the answer to the seventh sub-question is negative.

4.3.8 Sub-question test (4-2)

In this question, we are testing the null hypothesis (H_0) that the average benefit to the manager is the same when he sends a signal of high-quality information disclosure and the shareholder reacts with a low audit services quality strategy, compared to when the manager chooses to disclose low-quality information and the shareholder imposes a high audit services quality strategy.

The obtained probability value of the Z statistic is 0.761, greater than the significance level of 0.05. Therefore, we have enough evidence to reject the assumption of equality in the average interests of the manager.

Examining the average scores obtained from the test, which are 45.07 and 47 for the two groups respectively, we find that the difference in the average of the two groups is not statistically significant.

Therefore, the answer to the eighth sub-question is negative.

The negative answer to sub-questions (4-1) and (4-2) confirms that the equilibrium is not established at points (t_2, q_2, a_2).

5. Conclusion and suggestions

This research uses signalling games to consider information asymmetry in modeling the relationship between manager and shareholder. To this end, the manager and the shareholder are treated as players in a signaling game, operating within a joint-stock firm with varying degrees of internal control mechanisms. The manager can choose between high-quality or low-quality information disclosure strategies. At the same time, shareholders can adopt strategies of high or low expected return rates and opt for high or low-quality audit services. The four combinations of strategies proposed in the primary research questions can be analyzed within two distinct parts.

Firstly, the research findings affirm a positive response to the first and second research questions. This implies that in joint-stock companies with weak internal controls and managers disclosing low-quality information, achieving equilibrium of interests can be attained by shareholders adopting a high expected return strategy. Similarly, in an environment characterized by strong internal controls and high-quality information disclosure by managers, a Nash Bayesian equilibrium can be established through shareholders opting for a low expected return strategy. Any deviation from these game strategies by either party would result in a decrease in their respective interests. The findings of this research highlight the expected return of common stock as an effective mechanism for shareholders to counteract manager behavior and establish equilibrium in manager-shareholder relations. This result aligns with the research findings of Johnstone (2016) and Bashirimanesh et al. (2016).

The findings indicate a negative response to the third and fourth research questions. In other words, if joint-stock companies have weak internal controls and managers disclose low-quality information, the equilibrium of interests cannot be achieved by shareholders selecting high-quality audit services. Conversely, in an environment with strong internal controls and high-quality information disclosure by managers, shareholders cannot attain a Nash Bayesian equilibrium by opting for low-quality audit services. This suggests that the quality of auditing services cannot compensate for the quality of information disclosure by managers and bring about an equilibrium of interests between the parties. This result contradicts the research findings of Movahedi et al. (2019).

Additionally, the results of this research demonstrate that game theory plays a significant role in explaining the manager-shareholder relationship and identifying equilibrium points in the game can have a crucial impact on the decisions made by both parties, as supported by the research of Saffar et al. (2021).

In general, the research results show that shareholders' expected return can be considered a suitable tool for shareholders against the low quality of information disclosure. It means that if managers neglect the interests of shareholders by adopting opportunistic behavior in managing and controlling the company's affairs, shareholders can fine the managers and limit their freedom of action by demanding higher expected returns. The result of this appropriate action will be to balance the interests of the game parties. Also, if the managers disclose high-quality information, the shareholders by demanding low expected returns, can prevent the waste of the company's resources and encourage the managers to better pursue the company's interests, the result of which will be the optimization of the utility of both sides of the game. Also, the results of the research showed that at present, the audits performed by auditors do not have such a significant difference from each other in terms of quality, and it cannot be considered as a protective shield for shareholders to balance their interests against the low quality of information disclosure.

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IJAAF; Vol. 9, No. 2, Spring 2025, Serial 31

Iranian Journal of
Accounting, Auditing & Finance

Ferdowsi University of Mashhad

Quarterly

RESEARCH ARTICLE

Receivables and Tax Payable in Manufacturing Companies: Panel Analysis Reactions

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How to cite this article:
Adegbite, T. Adejare (2025). Receivables and Tax Payable in Manufacturing Companies: Panel Analysis Reactions. Iranian Journal of Accounting, Auditing and Finance, 9(2), 21-42. doi: 10.22067/ijaaf.2025.45464.1464
https://ijaaf.um.ac.ir/article_45464.html

ARTICLE INFO

Article History
Received: 2024-05-19
Accepted: 2024-11-15
Published online: 2025-04-17

Keywords:
Audit Committee Quality, Receivable, Taxable income, Tax payable, Total Asset

Abstract

This study examined the effect of receivables on taxes payable in listed Nigerian manufacturing companies. Data collected from the annual publications of selected thirty-four (34) Nigeria manufacturing companies between 2011 and 2023 were analysed with analytical tools such as pooled regression, fixed effects and random effects, and the Hausman test. The heteroskedasticity and VIF were also employed to determine the multicollinearity in the variables employed. Pearson Product Moment correlation (PPMC) was also used to determine the relationship among the variables. It was noted from the results attained from the analysis that receivables have a positive effect on payable taxes. It was invariably discovered that PBT, taxable income and revenue positively influenced tax payable. Still, total assets were negative, and audit committee quality negatively affected tax payable because a one percent increment in total assets and audit committee quality brought down tax payable. Conclusively, receivables significantly positively affect taxes payable in Nigerian manufacturing companies. It is recommended that receivable monitoring mechanisms or devices should be put in place by the government to monitor all the receivables of the organization to prevent artificial dwindling in tax payable and to enhance transparency in the financial reporting of manufacturing companies which will contribute to a more accurate and standardized assessment of tax implications.

https://doi.org/10.22067/ijaaf.2025.45464.1464

CC BY

NUMBER OF REFERENCES
43

NUMBER OF FIGURES
-

NUMBER OF TABLES
6

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

A rational organisation manages accounts receivables promptly for effective and efficient collection of all receivables without losing and missing sales from intense collection techniques. Managing accounts receivables maximizes enterprise value by balancing risk, profitability and liquidity. Wanguu and Kipkirui (2015) opined that receivables maintenance is not for bad debts' risk minimization nor sales maximization but for sales growth, which creates a vacuum for customers' credit sales.

It is opined by Douglas et al. (2018) that many organizations flourish on credit sales, which therefore encourages effective accounts receivable management as a crucial assessment of profit maximization. This translated into many firms indulging in sales enlargement with receivables for profit enlargement.

Account receivable, when properly managed, assists in debt collection due and helps in achieving organization cash flow requirements. This further helps eradicate the overtrading problem where an organization transacts or undercapitalizes because of huge debts outside an organization. Accounts receivable are considered significant and pertinent in the organisation's financial statement, apart from inventories, constituting a large proportion of the organisation's current assets. Capital invested in account receivables is nearly the same size as inventory and cash investment (Elsheikh and Hassanin, 2019). As observed in the financial statements of manufacturing companies, account receivables account for more than one-third of companies' current assets. According to Mazanec (2022), a well-planned, implemented and structured account receivable management (ARM) policy contributes positively to organization profitability where tax payable to the government is being determined. Profitability, an important desire of every organization, deals with financial returns realized by the company from goods and services sold after deducting the cost of sales and expenses. It is the parameter to gauge the overall organization financial potency.

Managing receivables is a critical aspect of financial management for manufacturing companies in Nigeria. Receivables represent the credit sales companies make to their customers, which are yet to be collected. Efficient receivables management is essential for sustaining healthy cash flows and maintaining profitability. In the context of Nigerian manufacturing companies, the effect of receivables on tax payable is a significant consideration that has implications for the organization's financial performance and tax obligations. In Nigeria, a company's taxable income, including revenues generated from sales, determines the tax payable by the organization. Receivables, representing unpaid sales invoices, can impact the company's taxable income and, consequently, its tax liability (Adegbite and Inyada, 2024). The timing of recognizing revenue from sales, particularly when credit sales are involved, can influence a company's taxable income in a given accounting period. Delays in collection of receivables negatively affect an organization's cash flow, which invariably downplays its financial potency to promptly meet tax obligations (Adegbite and Inyada, 2024).

Understanding the relationship between receivables and tax payable is essential for Nigerian manufacturing companies to effectively manage their financial operations and tax compliance. In Nigeria, manufacturing companies play a crucial role in the economy by contributing to industrial growth, employment generation, and revenue generation. However, the management of these companies' receivables can significantly impact their tax payable. Receivables are the money customers owe for goods or services provided on credit terms by the company. The problem arises when manufacturing companies have high levels of receivables that are not collected on time. This can lead to constrained cash flow, affecting an organization's potency to attain its tax obligations. In such cases, companies may face challenges in paying their taxes on time, leading to potential penalties and interest charges by the tax authorities. Additionally, according to Kuraesin et al. (2023), a high

level of uncollected receivables can impact the company's profitability, as it may result in bad debts that need to be paid off. This can further reduce the company's taxable income, potentially leading to lower tax payable. Therefore, the effect of receivables on tax payables in Nigerian manufacturing companies is a significant issue that needs to be addressed to ensure the financial health and compliance of these companies with tax regulations. This study aims to discover the impact of receivables on Nigerian manufacturing companies' tax payable, considering the country's unique economic and regulatory environment. By examining the factors that influence how receivables are managed and their implications for tax liabilities, this research seeks to provide insights that can help companies optimize their financial performance and tax planning strategies.

2. Literature review

2.1 Tax payable

Tax payable refers to the aggregated tax amount paid by the business, organization, or manufacturing company to the government, depending on taxable income, transactions or assets. It is the amount owed to the government after considering any tax deductions, credits, and exemptions that may apply. Tax payable is determined based on the jurisdiction tax laws and tax rates for a particular year. Tax remittance is important because it is a legal obligation that individuals and businesses must fulfill to contribute to funding essential government services and infrastructure. Tax payable by the organization is a source of revenue for the government irrespective of any ties (federal, state, and local). When the government realises this revenue is being employed to fund public services such as healthcare, infrastructure, defense, social welfare, and education, Taxes help redistribute wealth by collecting funds from those who can afford to pay more and utilize them to provide services and support to those in need. Tax payable helps promote social and economic equality by funding programs that benefit society. By fulfilling their tax obligations, individuals and businesses contribute to the functioning of the government and abide by the country's tax laws. Tax revenue plays a crucial role in maintaining economic stability by funding government initiatives and programs that promote economic growth, job creation, and investment in infrastructure. Tax payable contributes to the overall economic health of a country. Also, it is essential for the functioning of society and the government, and it is important for individuals and organizations to comply with and fulfill tax obligations to support the common good and contribute to the well-being of their community.

2.2 Receivable

Accounts receivable (also known as receivables) are the monetary value of goods or services owned by the company's customers. It represents the amount customers or clients owe for products or services received on credit. Companies typically have accounts receivable as an asset on their balance sheet, which is pertinent to the company's working capital. Managing accounts receivable effectively helps ensure a steady cash flow into the business, allowing the company to achieve its financial commitments bill payments, and investment growth opportunities (Ugwudioha and Onmonya, 2022). Accounts receivables are typically considered a current asset on an organization’s balance sheet. Its effective managed is essential for maintaining optimal working capital levels, which can impact the company's ability to fund operations, pay suppliers, and invest in new projects.

How a company manages its accounts receivable can impact its customer relationships. According to Soundarya et al. (2020), providing understandable payment terms and taking formidable steps to collect overdue payments professionally help maintain positive customer relationships and enhance the company's reputation. Careful monitoring of accounts receivable allows a company to identify potential bad debts or delinquent accounts early on. Imran (2018) opined that a company can reduce

or eradicate bad debt risks and financial losses by assessing credit risks, setting formidable credit limits, and implementing proactive collection strategies. Accounts receivable play a crucial role in financial reporting, providing information about a company's credit sales, outstanding balances, and the timing of cash inflows. Accurate accounts receivable reporting is essential for assessing the company's financial health and performance. Effective accounts receivable management is essential for optimizing cash flow, working capital, customer relationships, risk management, and financial reporting in a business (Owuor et al., 2021).

When a company recognizes revenue from sales or services provided on credit, the corresponding accounts receivable will also increase (Soundarya et al., 2020). This increment in accounts receivable may result in higher reported income for the company, as the revenue has been recognized even though the cash has not yet been received. Higher reported income led to higher taxable income, which increased the company's tax liability. In some tax jurisdictions, companies may be required to pay taxes on accrued income from accounts receivable even before the cash is collected. This impacts the timing of when the company pays taxes. Organizations need to manage accounts receivable effectively to ensure that cash is collected promptly to meet their tax obligations and manage their cash flow efficiently. Additionally, companies may need to consider accounting methods and tax regulations to accurately reflect the impact of accounts receivable on their tax payable.

If customers do not pay their receivables promptly, it can ignite cash flow complications for the company, which may affect its ability to pay bills, employees, or suppliers. Customers' default on their payments ultimately lead to bad debts, resulting in financial losses for the company, its profitability, and tax payable. Therefore, it is postulated that:

H_1: Receivables significantly impact tax payable in Nigerian manufacturing companies.

2.3 Taxable income

This is the organization's income, which is subject to tax by the government. It is realized by taking an individual's gross income (income before deductions and credits) and subtracting allowable deductions, exemptions, and credits. According to Adegbite and Adegbayibi (2023), taxable income determines how much tax an individual or business owes to the government. The tax rates and rules for determining taxable income vary by country which are set by the tax authorities. Some of the benefits of taxable income to the government, according to Adegbite and Adegbayibi (2023), is that taxable income provides a revenue source for government to finance public services like education, transportation, healthcare, defense, social welfare and infrastructure. This revenue helps the government meet its financial obligations and provide for the common good of society. It allows the government to collect taxes from individuals and businesses based on income, thereby promoting equitable wealth distribution.

Taxable income helps the government regulate the economy by influencing consumer spending, investment decisions, and overall economic activity. By adjusting tax rates and policies, the government can stimulate economic growth, control inflation, and maintain economic stability. Taxable income gives the government a powerful fiscal policy tool to manage the economy and address socio-economic challenges. The government can encourage specific behaviors, promote economic growth, and address budget deficits by adjusting tax rates, deductions, and credits. Taxable income is essential for funding the day-to-day operations of the government, including salaries of public employees, maintenance of public infrastructure, law enforcement, and other essential services. Without sufficient tax revenue, the government would struggle to meet its obligations and provide for the needs of its citizens. Taxable income, a gauge for payable taxes, plays a vital role in supporting the functioning of government and financing public services that contribute to the well-being and prosperity of society.

H_2: Taxable income significantly impacts tax payables in Nigerian manufacturing companies.

2.4 Total assets

Total assets are the aggregated values of every asset owned by the company or resources controlled with the economic value expected to flow for the company's future benefits. This is embedded with tangible assets such as equipment, inventory, and property, as well as intangible assets such as trademarks, goodwill, and patents (Olatunji and Adegbite, 2014). Total assets, the company's formidable component in the statement of financial position (balance sheet), are engaged in evaluating organizational value and financial health. Total assets can be calculated by adding the monetary value of all assets on the balance sheet representing the company's total investments. Total assets play a key role in determining the tax liability of individuals and businesses. For example, in Nigeria, taxes are imposed on certain types of assets, such as property, investments, or vehicles. The government uses asset valuations to assess the taxable amount and determine the appropriate taxes (Adegbite, 2020). Total assets can provide insights into wealth distribution within a population. Governments use data on total assets to understand income inequality, make policy decisions, and implement social programs to address disparities in wealth distribution. Monitoring total assets helps governments assess the overall financial health and stability of the economy but according to Lazarus et al. (2023), changes in total assets indicate economic growth or contraction, which can influence government policies related to fiscal management, monetary policy, and economic stimulus measures.

According to Adejare and Olatunji (2021), total assets are used to determine the organization's financial solvency and health. Regulatory authorities may require companies to report their total assets to ensure compliance with financial regulations and to evaluate debt obligations, potential liabilities, and other financial commitments. Total assets can also impact government revenue through taxes, fees, and other revenue sources. Governments may levy taxes on assets, such as property taxes, estate taxes, or capital gains taxes, to generate revenue to finance public services, social welfare provision and infrastructure projects (Adejarea and Akandeb, 2018). Total assets are an important measure that governments use to assess companies' tax liabilities, wealth distribution, economic stability, regulatory compliance, and government revenue. Monitoring total assets helps governments make informed policy decisions, ensure financial stability, and promote economic growth and welfare. Total assets are key in financial analysis and decision-making, particularly accounting, finance, and investing.

The significance of total assets cannot be underestimated because, according to Olatunji and Adegbite (2014), it provides valuable insights into an entity's financial health, performance, and growth potential, and identifies opportunities to make investment decisions, as well as assessing and managing financial risk. Understanding the composition and value of assets in an organization divulges potential risks such as asset concentration, obsolescence, or impairment, and effective risk management strategies involve optimizing the use of assets to maximize returns while minimizing exposure to potential losses (Adegbite, 2020). Total assets are essential for strategic decision-making such as resource allocation, capital budgeting, expansion initiatives, identifying areas of strength and weakness, guiding business leaders in allocating resources efficiently, investing in growth opportunities, and optimizing asset utilization to achieve optimal profitability where tax payable is gauged and determined. Therefore, it is postulated that:

H_3: Total assets significantly impact tax payable in Nigerian manufacturing companies.

2.5 Profit Before Tax (PBT)

This financial metric displays any organisation's operating profit before removing taxes. PBT is realized by the organization from the subtraction of all expenses from total revenue earned during a

precise period. This metric helps investors understand a company's profitability before considering the impact of taxes on its bottom line. PBT is the most pertinent gauge of an establishment's financial performance, and it extensively displays how the company generates profits from business activities before tax obligations.

PBT is a key factor in companies' tax planning strategies. Companies can assess their taxable income by analysing PBT and plan tax deductions, credits, and deferrals to optimize their tax liabilities and improve after-tax profitability (Eneisik et al., 2023). A consistent and growing PBT indicates that a company is efficiently managing its expenses, generating revenues, and operating profitably, which can instill confidence in investors and creditors. PBT serves as a valuable tool for management decision-making. By analyzing PBT, according to Adeboboye et al. (2022), management can evaluate the profitability of different business segments, assess the impact of cost-saving measures, recognize units for improvement, and proffer strategic decisions for financial performance enhancement. PBT is a critical financial parameter that exhibits valuable acumens into an organization's financial performance, operational efficiency, tax planning strategies, and overall financial health, making it an important measure for investors, management, and other stakeholders (Adeboboye et al., 2022; Adegbite and Adegbayibi, 2023; Duru et al., 2014).

H_4: PBT significantly impacts Tax Payable in Nigeria Manufacturing Companies

2.6 Revenue (REV)

Revenue refers to the organization's aggregated income earned in business operations, such as disposal of goods, interest, services, royalties, dividends, and other formidable income. Revenue is an income source for all manufacturing companies. It is essential for operating expenses, funding investment in equipment, infrastructure, research and development, paying employees, and generating profits. Without revenue, a manufacturing company cannot survive or grow sustainably (Adegbite et al., 2019). Revenue is crucial for funding growth and expansion initiatives. Manufacturing companies rely on revenue to invest in new technologies, expand production capacity, enter new markets, and develop innovative products. Higher revenue levels provide companies with the financial resources to support these expansion efforts. Revenue directly impacts a manufacturing company's profitability. Companies can enhance their profitability margins by increasing revenue through higher sales volumes, improved pricing strategies, and cost efficiencies. This enables them to generate returns for stakeholders, reinvest in the business, and withstand economic fluctuations.

Sindani (2018) opined that revenue is a key determinant of a manufacturing company's competitiveness in the market. Companies with higher revenue levels can invest in advanced technologies, automation, skilled workforce, efficient supply chains, and superior product quality. This competitive advantage allows them to attract customers, win contracts, and maintain market leadership. Revenue provides manufacturing companies with the resources to invest in innovation and research. Developing new products, enhancing existing offerings, and staying ahead of industry trends require financial support, which revenue helps to generate. Strategic investments in innovation can drive long-term growth and sustainability. Revenue is essential for maintaining the financial health of manufacturing companies. It enables them to meet financial obligations, repay debts, and build reserves for future uncertainties. Healthy revenue streams signal operational efficiency, customer demand, and overall market success, attracting investors and lenders. Revenue is a cornerstone of success for manufacturing companies, playing a vital role in their financial stability, growth, profitability, competitiveness, innovation, and overall sustainability. Effective revenue management and continuous focus on revenue generation are essential for manufacturing companies to thrive in a dynamic and competitive marketplace (Abubakar and Olowe, 2019; Adegbite and Fasina, 2019; Adejare, 2015; Aldubhani et al., 2022; Adejarea and Akandeb, 2018).

The link between revenue and tax payable is based on the concept of taxable income, which is the amount of income that is subject to taxation by the government. When a business earns revenue, it is not necessarily the same as taxable income. Taxable income is determined by subtracting allowable expenses, deductions, and credits from the total revenue earned by the business. This adjusted income is then used to calculate the taxes the business owes to the government. Properly tracking revenue, expenses, and deductions is essential for accurate tax reporting and compliance with tax laws (Adeboboye et al., 2022). In summary, revenue earned by a business is a key component in determining taxable income, affecting the tax payable amount. Therefore, it is hypothesized that:

H_5: Revenue significantly impacts tax payables in Nigerian manufacturing companies.

2.7 Audit Committee Quality (AUDCT)

The audit committee oversees a company's financial reporting processes, receivables, and tax payable management. It also significantly moderates the impact of receivables and tax payable on a company's financial statements, especially in the context of International Financial Reporting Standards (IFRS). According to Eneisik et al. (2023), strong Audit Committee quality promotes transparency and accountability in financial reporting. Companies with robust Audit Committee structures are more likely to accurately and transparently report their receivables and tax payable in accordance with IFRS guidelines. This transparency helps stakeholders and investors assess the company's financial performance and health accurately. Effective Audit Committee quality includes robust internal controls to prevent errors and misstatements in financial reporting. Companies with strong internal controls can better monitor and manage their receivables and tax payables, reducing the risk of inaccuracies or mismanagement in these areas (Adegbite, 2020). It also promotes ethical behavior within an organization, including the responsible management of receivables and taxes payables. Companies with a strong ethical culture are more likely to adhere to IFRS guidelines when accounting for these items, helping to maintain the integrity of their financial statements (Adegbite, 2020).

Audit Committee quality (ACQ) influences a company's approach to risk management. Companies that prioritize risk management are better equipped to assess and mitigate risks associated with receivables and tax payable, such as credit risk on receivables or tax compliance issues. By effectively managing these risks, companies can minimize the impact of receivables and tax payable on their financial performance. Adegbite and Adegbayibi (2023) opined that with diverse expertise and independence, ACQ can better provide oversight and guidance on managing receivables and tax payables. Sound audit committee quality enhances the integrity of financial reporting and mitigates the potential impacts of receivables and tax payable on their financial statements (Eneisik et al., 2023; Lazarus et al., 2023).

The quality of the audit committee can significantly impact how effectively these items are managed and reported per International Financial Reporting Standards (IFRS). A top-notch audit committee actively assesses the risks associated with receivables and taxes payable. Hanifah (2023) revealed that audit committees work with management to understand the company's credit policies, collection procedures, and tax planning strategies to identify potential risks and ensure appropriate controls are in place. The audit committee regularly monitors the company's receivables, such as ageing reports, collections activities, and tax liabilities, to ensure they are managed effectively. They review any significant changes in the allowance for doubtful accounts or tax provisions and question management about the reasons behind these changes.

Also, the audit committee is responsible for ensuring the company's compliance with relevant laws and regulations, including tax laws and accounting standards related to receivables. They review the company's tax filings and financial statements to ensure they are accurate and comply with IFRS

requirements. An effective audit committee also evaluates the company's internal controls on receivables and tax payable. They assess the design and operating effectiveness of controls that mitigate the risks of misstatements in these areas, including controls over revenue recognition, credit approvals, and tax calculations. The audit committee plays a key role in overseeing the external audit process, including the receivables and tax payable audit. They work closely with the external auditors to understand their audit plan, review the audit results, and address any significant issues or findings related to these areas.

By maintaining a high-quality audit committee that actively monitors and oversees the management of receivables, performance, and tax payables, companies can ensure accurate financial reporting, compliance with regulations, and effective risk management in these critical areas. This, in turn, enhances transparency, reliability, and credibility in the company's financial statements while assuring stakeholders. However, it is expected that:

H_6: The audit committee significantly moderates the relationship between receivables and tax payable in Nigerian manufacturing companies.

2.8 Theoretical review

2.8.1 Keynesian liquidity preference (KLP) theory

KLP theory was proposed by John Keynes (1936), which asserts that investors typically prefer liquid investments over illiquid ones, as liquidity provides flexibility and accessibility. The theory emphasizes the importance of maintaining an appropriate balance between cash and other assets. According to this theory, individuals and firms hold cash or inventory for various reasons, including transaction, speculative, precautionary, and compensation motives. In the context of working capital management, this theory highlights the significance of ensuring that sufficient funds are available for current assets to facilitate the smooth operation of day-to-day business activities. While profitability is a serious aspect for any organization, it is important to recognize that a healthy business may not always reflect immediate profit. The net profit figure reflects the balance between the values received and those expended. Operational efficiency is considered a key factor influencing profitability but not the sole determining factor. Various other elements such as market conditions, competition, external economic factors, and management decisions also play a crucial role in influencing profitability. Kuraesin et al. (2023) further elaborate on the multifaceted nature of profitability, indicating that profitability is influenced by a myriad of factors beyond just operational efficiency. Firms need to consider a holistic approach to financial management and decision-making for long-term sustainability and growth.

2.8.2 Theoretical review: IFRS perception

Receivables and tax payable are important components of a company's financial statements and are subject to specific regulations under International Financial Reporting Standards (IFRS). IFRS sets out guidelines that companies must follow when accounting for receivables and tax payable, ensuring consistency and transparency in financial reporting. Receivables represent amounts owed to a company by customers or other parties, typically for selling goods or services on credit. They are a key asset for a company as they represent future cash inflows. Under IFRS, receivables are recognized as having fair value on the balance sheet. Receivables are initially measured at transaction price and subsequently measured at amortized cost by employing the effective interest rate method. According to Owuor et al. (2021), impairment losses must be recognized if there is objective evidence that the receivable is not recoverable, following specific guidelines outlined in IFRS 9 Financial Instruments. IFRS 9 Financial Instruments provides guidelines on how companies should assess and account for impairment losses on receivables. If there is objective evidence of impairment, such as financial

difficulties of the debtor, the company must recognize an allowance for expected credit losses. This ensures that the carrying amount of receivables on the balance sheet reflects their recoverable amount, enhancing the accuracy of financial statements. Managing receivables effectively is crucial for a company's cash flow and liquidity. Monitoring ageing receivables, assessing credit risks, and establishing an appropriate credit policy are essential under IFRS management (Adegbite, 2020).

Tax payable, on the other hand, represents the amount of tax owed by a company to the government based on taxable income. It is a liability and must be recognized on the balance sheet when the company is legally obliged to pay taxes, typically at the year's end. Under IFRS, tax payable is measured as the expected amount to be remitted to the tax authorities, considering tax laws and regulations in the relevant jurisdictions (Adegbite and Inyada, 2024; Oktavia and Indrati, 2021). Further, any deferred tax liabilities or assets must be recognized on the balance sheet based on temporary differences between accounting and taxable profits. Tax payable represents the total tax owed by the company to the government based on taxable income. A liability must be recognized on the balance sheet when the company is legally obliged to pay taxes. Under IFRS, tax payable is measured at the amount expected to be paid to the tax authorities, considering tax laws and regulations in the relevant jurisdictions. In addition to recognizing current tax payable, companies must also account for deferred tax assets and liabilities under IFRS (Eneisik et al., 2023). Temporary differences between accounting and taxable profit give rise to deferred tax items. Companies must assess these differences and recognize deferred tax assets or liabilities on the balance sheet, reflecting the future tax consequences of these temporary differences. Proper accounting for tax payable under IFRS ensures compliance with tax laws and accurate financial reporting. Effective tax planning, monitoring tax regulations, and understanding the impact of tax liabilities on the company's financial statements are crucial aspects of managing tax payable in accordance with IFRS (Kristiana and Karnasi, (2024).

The impact of receivables and tax payable on a company's financial statements under IFRS is significant. Receivables directly affect a company's liquidity and cash flow, while tax payable represents an obligation that must be settled in the future. Kristiana and Karnasi (2024) revealed that proper accounting for receivables and tax payable is important for creditors, investors, and other stakeholders to accurately evaluate the company's financial performance and potency. Compliance with IFRS ensures transparency, comparability, and reliability in financial reporting, helping to build trust and credibility in the capital markets. Receivables directly impact a company's liquidity and cash flow. According to IFRS, when receivables increase, it indicates that the company is extending credit to customers, which could tie up cash flow until those receivables are collected (Aldubhani et al., 2022). Monitoring the level of receivables and their collection period is crucial for assessing a company's cash flow position. Companies need to carefully assess the credit risk associated with their receivables to determine the likelihood of customers' non-payment.

IFRS requires companies to account for impairment losses on receivables when there is objective evidence that the receivable is not recoverable. This can impact the company's profitability and financial health. Receivables and tax payable can impact a company's financial performance and reporting. Recognizing revenue from receivables and accounting for tax payable correctly are essential for presenting the company's financial position and performance as true and fair to stakeholders. Proper accounting for tax payable under IFRS ensures compliance with tax laws and regulations. It also allows companies to manage and plan their tax liabilities effectively. Understanding the impact of tax payable on the company's financial statements is crucial for tax planning and decision-making. IFRS requires companies to provide adequate disclosure of their receivables and tax payable in the financial statements. Transparent reporting of these items, including the methods used for measurement and any significant assumptions made, helps stakeholders assess the company's financial position accurately.

In summary, receivables and tax payable are significant components of a company's financial statements, and specific guidelines under IFRS govern their impact. Adhering to these standards enhances the transparency, accuracy, and reliability of financial reporting, providing stakeholders with valuable information for decision-making and assessment of a company's financial health.

2.9 Empirical review

Adeboboye et al. (2022) conducted a study on the impact of managing accounts receivable effectively on the financial performance of publicly Nigeria listed manufacturing firms. The study focused on analyzing how the average collection period affected a company's ROCE and EPS. The researchers sampled twenty (20) Nigeria listed consumer and industrial manufacturing companies, utilizing financial data from 2012 to 2021. Both descriptive and inferential analysis methods were employed. The study revealed that the average collection period had minimal negative effects on EPS. Moreover, normal collection periods slightly positively influenced returns on capital employed in industrial firms and had minimal negative effects on consumer goods companies. Comparative analysis indicated no significant difference in accounts receivable management impact on the performance of consumer and industrial goods firms. However, the study is restricted to accounts receivable and profitability, as opposed to this study, which gauged receivable impact on tax payable.

Owuor et al. (2021) showed the results of accounts receivable impact on Kenya's public universities' financial performance. Data collected through audited annual reports of selected 31 Kenyan public universities from 2017-2019 was analysed using panel analysis from the institutions' audited annual reports. The outcome revealed that accounts receivable management significantly indirectly impacted Kenya University's financial performance. Another study by Mutai and Kimani (2019) examined accounts receivable impacts on the liquidity of Kenya's technical training institutions. Responses through questionnaires were gathered from the population studied, which comprises 38 respondents who were equally selected from principals and accountants. The results of data analysis with correlation and multiple regression disclosed that ARM practices significantly affected the liquidity of Kenya's technical training institutions. Thus, this study emanated from Kenya, which is distinct from Nigeria's current study.

Mutiso and Mwangi, (2019) investigated The impact of RM on KKenyan. Data were assembled through questionnaires administered to manufacturing companies selected randomly from Thika and Ruiru municipalities. It was found that a weak positive correlation existed among credit terms, profitability and credit standards while a negative relationship existed between profitability and credit selection. Additionally, receivables collection and monitoring efforts revealed a relatively resilient positive connection with profitability. Conclusively, ARM impacts Kenya manufacturing companies' performance positively and significantly. The study garnered data from questionnaires administered to Kenyan manufacturing companies, which involved only a correlation matrix. Still, the current study extracted data from annual reports of Nigerian manufacturing companies that involved panel analytical tools.

Cipta et al. (2020) investigated accounts receivable turnover, credit growth and current ratio effects on Buleleng District Cooperatives' profits. The collected data were analysed using multiple linear regression analysis. Outcomes discovered that credit growth, current ratio, and accounts receivable turnover displayed no significant effects on Buleleng District Cooperatives' profits. Additionally, individually, accounts receivable turnover had a negative and insignificant impact on profits, while the current ratio had a positive yet insignificant effect. Credit growth individually had a significant negative impact on profits for these cooperatives. However, the study employed multiple linear regression analysis, which is absolutely different from the current study, which employed fixed effect, Hausman test, and random effect for analysis.

Agegnew (2019) appraised accounts receivable and the impact of cash turnover on Indonesian manufacturing companies' profitability. Research Data were gathered from thirty-two (32) Indonesia manufacturing companies' annual reports between 2011 and 2015 through purposive sampling. The results of data analyzed through regression analysis, t-tests and F-tests revealed that accounts receivable and cash turnover significantly impacted profitability. Another study was also established by Kuraesin et al. (2023) on the relationship between receivable turnover and profitability of Indonesian-listed manufacturing companies. Collected data were realized from 42 enterprises' financial statements with over 252 observations, which were analysed using multiple regression analysis. The result advocated that receivables positively, statistically and significantly impacted Indonesian listed manufacturing companies' profitability. Consequently, the study was ignited in Indonesia and employed regression for analysis as distanced from the current study, which was ignited in Nigeria with panel analytical tools.

Soundarya et al. (2020) investigated the influence of accounts receivable management on working capital at VKS Fabrics. Data from financial reports from 2014-2015 to 2018-2019 were analyzed using ratio and trend analysis to assess the efficiency of receivables management. Various ratios such as receivables to current Assets, total Assets, Sales, turnover, working capital and average collection period were computed to evaluate their impact. Descriptive research methods were employed, and results were presented using charts, tables, and graphs. The study concluded that VKS Fabrics had adequate accounts receivable management practices and provided recommendations for further improvement. In the same vein, Nwakaego et al. (2015) investigated the impact of ACM on the profitability of industrial goods in Nigeria. Collected data were from manufacturing companies' annual reports using multiple regression for the analysis. It was discovered from the analysis that accounts receivable impacted profitability positively with significant value. Meanwhile, policy forecasting of the study was limited to profitability as differed from this study with the policy prognostication of taxation In their 2018 study, Dirie and Ayuma (2018) investigated how ACM impacts SMEs' financial performance in Mogadishu, Somalia. Survey design was utilized to garner data from one hundred and two (102) SMEs through questionnaires in Mogadishu, Somalia. The Pearson correlation (PPMC) results show that ACM significantly impacts SMEs' financial performance in Mogadishu, Somalia. However, this study was effective in Mogadishu, Somalia, with questionnaires and PPMC, which differs from the current study in Nigeria, which involved published annual reports and panel data instruments.

Oktavia and Indrati (2021) examined the impacts of inventories, payables, and receivables on working capital. Inventories were measured by dividing the total cost of goods sold by the average inventory. At the same time, Receivables were calculated by dividing total credit sales by average receivables, and payables were realized by dividing total purchases by average trade payables. Thirty (30) listed Indonesia manufacturing companies were sampled between 2018 and 2019, where ninety (90) observations were gathered and analyzed with multiple regression. Findings from analysis displayed that receivables had a partial negative impact on working capital, while inventories had a partial positive effect. Debt, on the other hand, showed no significant effect on working capital. Overall, the study concluded that receivables, inventories, and payables impact working capital, with receivables having no partial effect, inventories positively influencing working capital, and debt not showing a significant partial effect. Established in Indonesia, the study was confined to inventories, payables, and receivables' impacts on working capital. However, the current research in Nigeria is confined to tax payable and receivable.

Duru and Ubesie (2016) investigated how accounts receivable impacted Nigerian manufacturing firms from 2000 to 2011. Various variables such as debt ratio, sales growth, and accounts receivable, were considered. The regression analysis of data collected from annual reports of selected

manufacturing firms revealed that the debt ratio, sales growth rate, and accounts receivable positively, significantly, and statically impacted the profitability of Nigerian manufacturing firms. Owuor et al. (2021) investigated ACM's impact on financial performance in Kenya's public universities. The finding of the analysis of data collected from annual reports of 31 chartered Kenya public universities from 2017 to 2019 indicated that they were utilized, with data analysis conducted using SPSS Version 25. The findings indicated that ACM had an insignificant effect on Kenya University's financial performance. Owuor et al. (2021) concluded that effective accounts receivable management played a crucial role in the financial performance of chartered Kenya public universities. Nevertheless, the study was conducted in Kenya public universities with the scope of 2017 to 2019, but this research was conducted on Nigerian manufacturing companies with the scope of 2011 and 2023.

In a study conducted by Muthoni et al. (2020), the link between ACM and Nairobi listed manufacturing firms' financial performance was examined. The study employed a population of one hundred and forty-seven (147) accounts and finance staff from all Nairobi-listed manufacturing firms from April 2016 to October 2016. Self-administered questionnaires were also used to sample the minds of 147 respondents, and these were analyzed using inferential and descriptive statistical methods. The findings divulged that substantial, significant and progressive relationships exist amidst the financial performance of ACM and Nairobi-listed manufacturing firms. Nonetheless, a questionnaire was the data collection instrument engaged in the study and was carried out in Nairobi, but it was different from the current study, which majorly employed annual published reports as the instrument and was conducted in Nigeria.

Imran (2018) focused on receivables management's influence on the profitability of listed companies. The study considered variables such as debt, sales growth and accounts receivable. Secondary data spanning from 2006 to 2017 was used for the research. Through the application of multiple regression analysis, the study assessed the hypotheses. The outcomes indicated that accounts receivable displayed a negative and insignificant correlation with profitability. On the other hand, debt showcased a positive yet insignificant relationship with profitability. Additionally, sales growth was found to have a positive but non-significant association with profitability based on the analysis. In another study, Jindal et al. (2017) investigated the impact of the efficiency of receivables management on the profitability of India companies from 2009 to 2016. The results demonstrated a positive and noteworthy correlation between the debtor's turnover ratio and India companies' profitability. This suggests that efficient management of receivables, as reflected in a higher debtor turnover ratio, contributes positively to the companies' profitability in India. Imran's (2018) research was restricted to 2017, but this study extended to 2023; therefore, the policy formulation differs.

Mbarushimana and Kengere (2023) investigated the effect of ARM practices on Rwandan manufacturing companies' financial performance. Cross-sectional surveys and structured questionnaires were employed, and 61 employees from Cimerwa were examined. The findings from the regression revealed that credit analysis and credit policy had a statistical, significant, and positive impact on Rwanda's manufacturing companies' financial performance. It was concluded that ARM had a positive, significant and statistical impact on Rwanda manufacturing companies' financial performance. The study employed structured questionnaires against the current study which fully involved annual reports of Nigeria manufacturing companies. Lazarus et al. (2023) investigated inventory conversion and account receivables on the performance of Ghana-listed manufacturing companies. Panel data collected from six (6) Ghana Listed manufacturing companies' financial statements from 2011 to 2020 were analyzed with panel data correlation and multiple regressions. The outcome showed that account receivables and inventory conversion statistically, significantly, and negatively impacted the ROA performance of Ghana Listed manufacturing companies. The study emanated from Ghana, but Nigerian manufacturing companies were not captured.

Hanifah (2023) analyzes receivable turnover and current ration influence on Profitability in Indonesian selected companies from 2016 to 2021. The data collected from Indonesian companies' financial reports analyzed with path analysis showed that the current ratio and receivable Turnover had a significant effect partially or simultaneously on profitability for Indonesian selected companies. Thus, the study was restricted to selected Indonesian companies as they were distant from Nigerian companies. In another study, Yusup and Hariani (2023) examined the Current Ratio, Accounts Receivable and Inventory Turnover effects on Return on Assets (ROA) in Indonesia. The study population was listed as beverage and food companies from 2015 to 2019. The outcome from the quantitative causal analysis indicated that accounts receivable and inventory turnover significantly and negatively impacted ROA. Still, the current ratio significantly and positively impacted ROA in Indonesian beverage and food companies. However, the study was ignited in Indonesia beverage and food companies but not in Nigeria manufacturing companies.

Kristiana and Karnasi (2024) determined the working capital effect on ROA in listed twenty-seven (127) Indonesian manufacturing companies. The meaningful data analysed using regression were obtained from annual reports of listed Indonesian manufacturing companies between 2018 and 2022. The results vindicated that inventory and accounts receivable had impacted ROA negatively and significantly. Nevertheless, the study employed regression for analysis which is different from the current study which engaged panel analytical tools for analysis. In another related study from Nigeria, Adegbite and Inyada (2024) investigated the viable effect of working capital on the tax payable to manufacturing companies in Nigeria. The study gauged Ten (10) manufacturing companies listed on the stock exchange between 2010 and 2022. Panel analysis components such as fixed effect, random effect model and FGLS, autocorrelation, Hausman and heteroskedasticity test were engaged. Results divulged that receivable, payable, and inventory were favourably significant in terms of tax payable. The study ultimately concluded that working capital statistically, progressively and significantly influenced tax payable in manufacturing companies in Nigeria. However, the study focused on working capital entirely but not in the same line with the current study which focused majorly on receivable in manufacturing companies.

Extant studies are limited to receivable management effects on profitability in Nigeria, developed and emerging countries (Dirie and Ayuma, 2018; Cipta et al., 2020; Duru and Ubesie, 2016; Imran, 2018; Kuraesin et al., 2023; Muthoni et al., 2020; Mutiso and Mwangi, 2019; Owuor et al., 2021; Purwanti, 2019) while other extant researchers confined their studies to receivable impacts on working capital (Kristiana and Karnasi, (2024); Adegbite and Inyada, (2024); Mutai and Kimani, 2019; Jindal et al., 2017; Owuor et al., 2021; Soundarya et al., 2020). However, this study extended its research to receivable and tax payable in Nigerian manufacturing companies, which is scarce among the extant research. Also, none of the extant researchers employed panel analytical tools to analyse the data garnered, which distinguished this study from others.

By examining the Nigerian context, the study can provide insights into how receivables management practices affect tax liabilities in a developing economy with unique tax regulations and business environments. This local perspective adds richness to the existing literature, which is often dominated by research from more developed countries. Understanding the relationship between receivables and tax payable in Nigeria can offer valuable insights for businesses operating there. The findings can help companies optimize their receivables management strategies to minimize the impact on tax liabilities and improve overall financial performance. This practical relevance enhances the applicability of the research findings to real-world business scenarios. The study can inform policymakers and tax authorities in Nigeria about the potential implications of receivables management on tax collections. By identifying how companies' receivables practices influence their tax payable, policymakers can design targeted interventions or regulatory measures to address any

identified challenges or loopholes in the taxation system. This can contribute to more effective tax collection and compliance efforts in the country. The research also contributes to theoretical literature by expanding our understanding of the relationship between receivables and tax payable within the broader financial management and taxation framework. It can shed light on how receivables impact tax liabilities and contribute to theoretical debates on the intersection of accounting, taxation, and corporate finance. The study introduces innovative research methods or analytical approaches to investigate the link between receivables and tax payable in Nigeria. By utilizing sophisticated quantitative techniques or longitudinal analyses, the research can push the methodological boundaries of existing literature and set new standards for studying this complex relationship. In conclusion, analyzing the effect of receivables on tax payable in Nigeria not only fills a gap in the literature but also offers practical, policy, theoretical, and methodological contributions that can enhance our understanding of this important financial and tax management issue.

3. Methodology

Data were sourced from annual publications of selected thirty-four (34) Nigeria manufacturing companies between 2011 and 2023 with four hundred and forty -two (442) observations. A panel model was used to analyse the data to determine the receivable effects on taxes payable to Nigerian manufacturing companies. Panel data analysis which is entrenched with a fixed effect model, pooled regression, Random effect, and FGLS, as well as the Hausman test, was employed in the study. The heteroskedasticity and VIF were also employed to determine the multicollinearity in the variables employed. Pearson Product Moment correlation (PPMC) was also used to determine the relationship among the variables.

3.1 Model specification

To analyse the effect of receivables on tax payable, receivables were assigned as an independent variable while Tax Payable was a dependent variable. Total Assets, Profit Before Tax, Net Income, and Revenue are control variables, and the audit committee is a moderating variable. Models are stated as follows:

$$TAXPBLE = f\ (RECEIVABLES, \mu) \quad (1)$$

$$TAXPBLE = f(RECEIVABLE, TOTAL\ ASSET, PBT, TAXABLE\ INCOME, REV, AUDCT, \mu) \quad (2)$$

$$TAXPBLE = a_0+\beta_1 RECEIV+\beta_2 TOTASET+ \beta_3 PBT+ \beta_4 TAXINC+\beta_5 REV+ \beta_6 AUDCT +\mu_1 \quad (3)$$

- Fixed Effect Model

$$Yit = \beta 0 + \beta Xit + uit \quad (4)$$

$$TAXPBLEit = \beta 0 + \beta 1 RECEIVit + \beta 2 TOTASETit + \beta 3 PBTit + \beta 4 TAXINCit + \beta_5 REVit+ \beta_6 AUDCT + y2E2 +\ldots+ ynEn + uit \quad (5)$$

$$TAXPBLEit = \beta 0 + \beta 1 RECEIVit + \beta 2 TOTASETit + \beta 3 PBTit + \beta 4 TAXINCit + \beta_5 REVit+ \beta_6 AUDCT+y2E2 +\ldots+ ynEn + \delta 2T2 +\ldots+ \delta tTt\text{-}1 + uit \quad (6)$$

- Random Effect Model

$$Yit = \beta 0 + \beta Xit + uit + \varepsilon it \quad (7)$$

$$TAXPBLEit = \beta 0 + \beta 1 RECEIVit + \beta 2 TOTASETit + \beta 3 PBTit + \beta 4 TAXINCit + \beta_5 REVit+ \beta_6 AUDCT + \gamma 2E2 +\ldots+ \gamma nEn + uit + \varepsilon it8 \quad (8)$$

4. Results and discussion

Table 1. Correlation

	TAXPBLE	RECEIV	TOTASET	TAXINC	PROBTAX	REV	AUDCT	AUDCT* RECEIV	AUDCT * TAXPBLE
TAXPBLE	1.000								
RECEIV	0.394*	1.000							
TOTASET	0.540*	0.431*	1.000						
TAXINC	0.493*	0.472*	0.663*	1.000					
PROBTAX	0.551*	0.325*	0.484*	0.431*	1.000				
REV	0.692*	0.428*	0.489*	0.655*	0.639*	1.000			
AUDCT	0.268*	0.030	0.297*	0.276*	0.293*	0.267*	1.000		
AUDCT*RECEIV	0.447*	0.583*	0.483*	0.508*	0.380*	0.472*	0.164	1.000	
AUDCT*TAXPBLE	0.589*	0.363*	0.531*	0.489*	0.546*	0.474*	0.342*	0.430*	1.000

Table 1 displays the results of the correlation matrix, which is ignited to examine the relationships between TAXPBLE and receivable. It is discovered that RECEIV possesses a positive significant connection with TAXPBLE with the value of (0.3949*), which shows the absence of multicollinearity between TAXPBLE and RECEIV. Also, TOTASET, in the same vein, displays a positive relationship with TAXPBLE (0.5400*). Furthermore, TAXINC, PROBTAX and REV positively connected with TAXPBLE with significant values of 0.4933*, 0.5519* and 0.6921*, respectively, in sampled Nigeria manufacturing companies. Similarly, AUDCT showed a positive relationship with TAXPBLE (0.2687*). Lastly, the moderators (AUDCT*RECEIV and AUDCT*TAXPBLE) divulged a significant relationship with TAXPBLE (0.447* and 0.5893* respectively). These values also display the nonattendance of multicollinearity amid the sampled variables in determining the effect of receivables on tax payable in Nigeria manufacturing companies.

VIF is also ignited to examine the heteroskedasticity among variables. However, it is realized from the results in Table 2 that heteroskedasticity presents in TOTASET and REV with values of 118.92 and 75.51, respectively, which are higher than the benchmark of 10 for the parameter. This springs out of Robust Regression in Table 3 to eradicate heteroskedasticity.

Table 2. Variance Inflation Factor (VIF)

Variable	VIF	1/VIF
TOTASET	118.92	0.008
REV	75.51	0.013
PROBTAX	8.90	0.112
TAXINC	2.68	0.372
RECEIV	1.36	0.734
AUDCT	1.18	0.846
Mean VIF	34.76	

Source: Author's Computation (2024)

Table 3. Impact of receivable on tax payable in Nigeria manufacturing companies

	(1)	(2)	(3)	(4)	(6)	(7)

TAXPBLE	Pooled Regression	Robust Regression	AUDCT* RECEIV	AUDCT* TAXPBLE	Fixed Effect Model	Random Effect Model
RECEIV	0.027**	0.027*	-0.088	0.010**	-0.008	0094
	(0.017)	(0.074)	(0.278)	(0.010)	(0.768)	(0.031)
TOTASET	-0.026	-0.026	-0.038	-0.061***	-0.044***	-0.054***
	(0.341)	(0.406)	(0.194)	(0.000)	(0.000)	(0.000)
TAXINC	0.0071***	0.0071**	0.0073***	0.002***	0.001***	0.001***
	(0.000)	(0.015)	(0.000)	(0.004)	(0.008)	(0.002)
PROBTAX	0.318***	0.318***	0.321***	0.063***	0.022**	0.034***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.047)	(0.004)
REV	-0.000	-0.000	0.0034	0.020***	0.016***	0.019***
	(0.995)	(0.996)	(0.710)	(0.000)	(0.000)	(0.000)
AUDCT	-1.538	-1.538	-4.128	-4.341***	-8.585***	-6.342***
	(0.416)	(0.323)	(0.114)	(0.000)	(0.000)	(0.000)
AUDCT* RECEIV			0.0221***		0.032***	0.056***
			(0.012)		(0.016)	(0.010)
AUDCT* TAXPBLE				0.145***	0.157***	0.155***
				(0.000)	(0.000)	(0.000)
_Cons	4.48023	4.48023	8.01563	2.146***	4.554***	3.264***
	(0.675)	(0.556)	(0.000)	(0.000)	(0.000)	(0.000)
N	442	442	442	442	442	442
R^2	0.728	0.728	0.729	0.790	0.791	
adj. R^2	0.723	0.723	0.724	0.790	0.789	

Source: Author's Computation (2024)

Pooled regression, as shown in Table 3, has been discarded because of the presence of heteroskedasticity in TOTASET and REV. Robust regression is ignited to correct the presence of heteroskedasticity, as shown in Table 3. To discover the appropriate model out of pooled regression, fixed model and random model, the Hauman test must be done, as shown in Table 4. The results from the Hauman test supported the Random model because Prob>chi2 = 0.4650 is above 0.05. In addition, the Breusch and Pagan Lagrangian multiplier test (Band PL) is analyzed to deduce the appropriate model between the random model and Pooled regression which invariably supports the random model as shown in Table 5.

The random effect model in Table 3 shows that a unit increase in RECEIVABLES increased Tax payable by 0.094% and revealed that RECEIVABLES positively affected Tax payable (β = 0094, p = 0.031 < 0.05). One unit increase in TOTASET led to a decrease in tax payable by -0.054%, indicating a negative effect of TOTASET on Tax payable (β= -0.054, p = 0.000 < 0.05). The result also shows that a unit increase in TAXINC increased tax payable by 0.0018%, indicating a positive effect of TAXINC on Tax payable (β = 0.00189, p = 0.002 < 0.05). However, a unit increase in PROBTAX led to an increase in Tax payable by 0.034%, which further indicates that there was a

positive effect of PROBTAX on tax payable (β = 0.0340 p = 0.004 < 0.05). Additionally, a one unit increase in REV increased Tax payable by 0.019%, proving a positive effect of REV on Tax Payable (β= 0.019, p = 0.000 < 0.05). AUDCT, which is audit committee quality, negatively affected tax payable because a one percent increment in audit quality brings down tax payable by 6.3%. (β= -6.34246***, p = 0.000 < 0.05). AUDCT*RECEIV and AUDCT*TAXPBLE had a positive moderating role between receivables and tax payable with the value of (β= 0.05683***; 0.155***, p = 0.010; 0.000 < 0.05 respectively). This divulges that A UDCT significantly moderated the relationship between receivables and tax payable in Nigeria manufacturing companies.

Table 4. Hausman test

	(b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
RECEIV	-0.008	0.009	-0.017	
TOTASET	-0.044	-0.054	0.009	0.003
TAXINC	0.001	0.001	-0.000	
PROBTAX	0.022	0.033	-0.011	
REV	0.016	0.019	-0.002	0.001
AUDCT	-3.289	-6.642	-7.533	3.264
AUDCT*RECEIV	0.002	-0.000	0.003	
AUDCT*TAXPBLE	0.157	0.154	0.002	
chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 7.78			Prob>chi2 = 0.465	

Source: Author's Computation (2024)

Table 4 displayed the Hausman test's decision on either fixed or random effects. Hausman test absolutely advocated for the random effect model preference as the viable model for this study interpretation and analysis because Prob>chi2 equals 0.4650, which is more than 0.05.

Table 5. Breusch and Pagan Lagrangian multiplier test (Band PL) for Random Effects
TAXPBLE [companies, t] = Xb + u [companies] + e [companies, t]

Estimated Results	Var	SD = sqrt (Var)
TAXPBLE	4.01e+13	6328854
E	2.11e+11	459287.4
U	0	0.000
Test: Var(u) = 0	chibar2(01) = 54.54	Prob > chibar2 = 0.000

Source: Author's Computation (2024)

Band PL in Table 5 is analyzed to deduce the appropriate model between the random model and Pooled regression. It is discovered that the random effect model is appropriate because Prob > chibar2 = 0.0000 which is below 0.05.

Table 6. Correlation matrix of residuals

	__e1	__e2	__e3	__e4	__e5	__e6	__e7	__e8	__e9	__e10
__e1	1.000									
__e2	-0.248	1.000								
__e3	-0.443	0.146	1.000							
__e4	-0.543	-0.121	0.327	1.000						
__e5	-0.712	0.554	0.695	0.478	1.000					
__e6	0.583	-0.196	-0.740	-0.451	-0.790	1.000				
__e7	-0.952	0.326	0.551	0.536	0.808	-0.658	1.000			
__e8	0.545	-0.139	0.033	-0.372	-0.313	0.011	-0.619	1.000		
__e9	0.548	-0.377	-0.516	-0.605	-0.829	0.667	-0.720	0.560	1.000	
__e10	-0.830	0.495	0.384	0.529	0.670	-0.349	0.860	-0.599	-0.545	1.000

Breusch-Pagan LM test of independence: chi2 (45) = 33.887, Pr = 0.1264

Source: Author's Computation (2024)

The correlation matrix of residuals in Table 6 was analyzed with the involvement of the Breusch-Pagan Lagrangian multiplier (LM) to determine the presence of cross-sectional dependence among the variables of the sampled manufacturing companies because cross-sectional dependence is one of the major problems with a micro panel with 10 years and above. The null hypothesis is that residuals across all entities are uncorrelated. The result of pr in Table 6, which is 0.1264 greater than 0.05, depicts the absence of cross-sectional dependence among the variables examined, which ultimately displays that residuals across all entities are correlated.

5. Discussion of findings

This study investigated the effect of receivables on tax payables in listed Nigerian manufacturing companies. Data collected were analysed with analytical tools such as pooled regression, fixed and random effects, and the Hausman test. It was noted from the results attained from the analysis that receivables have a positive effect on tax payables. This is in line with the submission of Adegbite and Inyada (2024), Aldubhani et al. (2022), Kuraesin et al. (2023), Oktavia and Indrati (2021); and Owuor et al. (2021) but discounted the submission of Adeboboye et al., (2022); Duru et al., (2014); Oktavia and Indrati, (2021); and Soundarya et al., (2020). It was also revealed that total assets decrease the tax payable by an organization; that is, total assets negatively affect the tax payable. This negated the view of Adegbite and Inyada (2024) and Owuor et al. (2021) but derailed the advocacy of Sindani (2018). It was further discovered that PBT increases tax payable as supported by the view of Adegbite and Inyada (2024), Jindal et al. (2017), Muthoni et al. (2020), Odondi et al. (2015) but declined the submission of Adegbite and Inyada, (2024); Aldubhani et al., (2022); and Muthoni et al., (2020).

Taxable income was also seen increasing tax payable by an organization; this shows that the more taxable income there is, the more tax payable by the manufacturing companies. This distanced from the verdicts of Adegbite and Inyada (2024), Olatunji and Adegbite (2014), Aldubhani et al. (2022), and Owuor et al. (2021) but concurred with the verdicts of Sindani (2018); Duru et al., (2014). Furthermore, revenue positively influences Nigerian manufacturing companies' tax payable to the government; that is, revenue increases the tax payable by an organization to the government. This submission is never derailed from the submission of Adegbite and Inyada (2024) and Owuor et al. (2021) but not in line with Aldubhani et al. (2022) and Muthoni et al. (2020), where the negative significant effect revenue and profitability on tax payable of manufacturing firm are established. AUDCT, which is audit committee quality, is negatively affected because a one percent increment in audit quality brings d This is because audit committees work with management to understand the company's credit policies, collection procedures, and tax planning strategies to identify potential risks and ensure appropriate controls are in place. AUDCT*RECEIV and AUDCT*TAXPBLE had a

positive moderating role in the relationship between receivables and tax payables. This divulges that AUDCT significantly moderated the relationship between receivables and tax payables in Nigerian manufacturing companies, which is in line with the submission of Adegbite and Inyada (2024).

6. Conclusion

This research analyzed the effect of receivables on tax payables in Nigerian manufacturing companies. The study provides empirical evidence of this effect within the context of Nigeria. Data collected from annual publications of selected thirty-four (34) Nigerian manufacturing companies between 2011 and 2023 were analysed with analytical tools such as pooled regression, fixed and random effects, and the Hausman test. The heteroskedasticity and VIF were also employed to determine the multicollinearity in the variables employed. Pearson Product Moment correlation (PPMC) was also used to determine the relationship among the variables. Findings from the study revealed that receivables have a significant positive effect on tax payables. Conclusively, receivable has a positive significant effect on tax payable; when a company recognizes revenue from sales or services provided on credit, the corresponding accounts receivable will also increase, which will invariably upsurge tax payable by Nigeria manufacturing companies to the government. Also, this increment in accounts receivable may result in higher reported income for the company once the revenue has been recognized even though the cash has not been received; higher reported income leads to higher taxable income, which may result in an increment in the company's tax liability (tax payable). It is recommended that receivable monitoring mechanisms or devices should be put in place by the government to monitor all the receivables of the organization to prevent artificial dwindling in tax payable and to enhance transparency in the financial reporting of manufacturing companies which will contribute to more accurate and standardized assessment of tax implications.

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IJAAF; Vol. 9, No. 2, Spring 2025, Serial 31

Iranian Journal of
Accounting, Auditing & Finance

Ferdowsi University of Mashhad

Quarterly

RESEARCH ARTICLE

The Effect of Corporate Sustainability Performance on the Speed of Achieving the Optimal Capital Structure: The Generalized Moments Approach

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How to cite this article:
Ahmadi Farsani, F. and Alahyari, A. A. (2025). The Effect of Corporate Sustainability Performance on the Speed of Achieving the Optimal Capital Structure: The Generalized Moments Approach. Iranian Journal of Accounting, Auditing and Finance, 9(2), 43-55. doi: 10.22067/ijaaf.2025.45190.1445
https://ijaaf.um.ac.ir/article_45190.html

ARTICLE INFO

Article History
Received: 2024-01-13
Accepted: 2024-08-12
Published online: 2025-04-15

Keywords:
Capital Structure Adjustment Speed, Corporate Sustainability performance

Abstract

The capital structure adjustment speed indicates the movement of companies towards the optimal capital structure. The optimal financial leverage is said to be a combination that is affected by the correct and targeted use of financial resources and the acquisition of reasonable and suitable returns with the risks of these resources. The present study seeks to track the effect of corporate sustainability performance on the speed of achieving the optimal capital structure. A sample of 136 listed companies on the Tehran stock exchange selected according to the systematic exclusion pattern was collected for 13 years from 2010 to 2022 to achieve the research objectives. A multivariate regression model with the generalized moments approach (GMM) was used to test the research hypotheses. The results showed that the circuits with higher stability performance could quickly cover the distance between the actual capital structure and the target and achieve optimal capital structure. Therefore, it is essential to address the level of corporate sustainability performance in capital structure and its optimization. The current study provided evidence that a company's sustainability performance a comprehensive approach reflecting total effects plays a crucial role, potentially serving as the central pillar of its capital structure. Moreover, access to financing sources should be adequate.

https://doi.org/10.22067/ijaaf.2025.45190.1445

NUMBER OF REFERENCES
38

NUMBER OF FIGURES
-

NUMBER OF TABLES
5

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

The most important task for financial managers in achieving companies' goals is optimally combining financial resources in the capital structure (Oino and Ukaegbu, 2015; Rostami et al., 2022). As long as the companies choose an optimal combination of debt and equity in their financing methods to minimize financing costs, this action will maximize the shareholders' interests. Therefore, it is necessary to discuss the speed of adjusting the financial leverage towards the optimal leverage because one of the main reasons for the failure of companies is insufficient investment and inappropriate financing (Salehi et al., 2023). The speed of adjustment of financial leverage is when the company adjusts its capital structure and moves towards the optimal leverage it has already targeted and achieved (Amin and Liu, 2020). Optimal leverage is crucial for the growth and survival of companies, as it directly impacts their risk and expected returns. Studying financing decisions and achieving optimal leverage is essential, as it can influence bankruptcy probability and is related to the company's credit risk (Rostami et al., 2022).

Corporate sustainability performance reflects how a business unit incorporates social efficiency, environmental protection, economic growth, and governance elements. Now, businesses and stakeholders understand that these non-financial indicators were previously ignored, not only from a financial perspective but also in terms of risk avoidance, cost control, market reputation, and customer relationship improvement (Bae et al., 2019; Cao et al., 2019), are closely related to many aspects of the company's strategic development. Sustainability reporting assures shareholders and stakeholders that non-financial risks and opportunities associated with various organization departments' activities are identified according to a basic plan (Ho et al., 2021). The sustainability reporting framework can be analyzed from multiple perspectives, adhering to international guidelines (Asif et al., 2024). The importance of this type of reporting is such that it is explicitly mentioned in the laws of some countries. Therefore, government regulations play a crucial role in the disclosure of sustainability reports. Moreover, rules that mandate sustainability reports help reduce debates regarding their validity (Birkey et al., 2016). The emergence of the concept of sustainability in the last century as one of the most important and interesting topics regarding the activities of companies includes the commitments of the business unit to carry out fundamental reforms to build a just world with prosperity and comfort for everyone, which is It, the surrounding environment, as well as the primary culture of the people, are preserved. The contribution of the next generations will also remain from these resources (Bilbao-Terol et al., 2016). The reflection on creating a uniform system for sustainability reporting has started a critical discussion among researchers, professionals, and policymakers aware of these complications and possibilities arising from this reporting (Beck et al., 2017; De Oliveira et al., 2024). Capital structure is usually a source of financing a company's business to create added value for stakeholders. It encompasses both debt and equity financing, each with its associated costs and benefits. Therefore, lower capital costs increase access to financial resources and ultimately reduce leverage and information asymmetry (Adeneye et al., 2023).

Corporate sustainability encompasses numerous studies on hybrid sustainability methods for determining the cost of equity and debt. Still, the impact of sustainability performance on the speed of capital structure adjustment has yet to be investigated. According to the companies that use performance, they have higher stability, higher access to external financing, and, finally, higher speed in achieving optimal capital structure. Thus, this research investigates whether sustainability performance accelerates the adjustment of financial leverage towards optimal capital structure. Because in general, corporate sustainability is an economical and pragmatic approach with the potential to create opportunities and risks for trade and commerce. Corporate sustainability is a broad, complex, and evolving concept that includes diverse attitudes and ideas; this general concept can create a kind of stability in a company and guarantee its movement in the competitive market. Also,

companies should seek to achieve the optimal level of leverage that seeks the maximum value for shareholders and consider the high cost of capital in the country and the need to reduce it, therefore addressing the impact of corporate sustainability performance. It can have a capital structure based on the speed of adjustment; it is essential. The subsequent sections of this research will present the development of the study's theoretical foundations, hypotheses, and empirical framework. Then, the methodology and operational definitions of the research variables are presented, and finally, the findings and conclusions of the research are presented.

2. Development of theoretical principles and research hypothesis

2.1 Speed of adjustment of capital structure

Capital structure adjustment speed reflects how companies progress toward their optimal capital structure. The two primary sources of financing in companies are debt and equity issuance (Arikawa and Huang, 2022). The optimal capital structure is a combination affected by the correct and targeted use of financial resources and the acquisition of reasonable and suitable returns with the risks of these resources. The speed of movement of economic enterprises toward the optimal ratio depends on various factors, and the cost of adjusting the capital structure is one of the most critical factors (Rostami et al., 2022, 2023). Do et al. (2022) found that the effect of product market threats on leverage adjustment is more pronounced for firms with poor governance quality and exposure to product market threats. Achieving the target capital structure is crucial as it enhances the company's value. Arikawa and Huang (2022) stated that the adjustment speed of the capital structure was investigated using a partial adjustment model. The results showed that the speed of adjustment in emerging markets is plodding, and Vietnamese companies need to adjust their capital structure with high flexibility toward optimal value. Also, Vietnamese companies mainly use debt as external financing. The most critical issue in researching the capital structure of economic enterprises is the correct estimation of their movement speed toward the target lever. Vo et al. (2022) found that, on average, companies tend to adjust their capital structure more quickly in the post-COVID-19 period. In addition, companies located in countries where COVID-19 is causing more severe damage adjust their target leverage faster than those in less affected countries. Most economic enterprises deviate from their target capital and often act to adjust their capital structure when the benefits of altering the capital structure will be greater than its costs. Therefore, it is necessary to discuss the speed of changing the financial leverage towards optimal leverage because one of the main reasons for the failure of companies is insufficient investment and inappropriate financing (Abuhommous, 2021). Rostami et al. (2022) stated that in family companies, the speed of adjustment of financial leverage towards optimal leverage is faster than in non-family companies. Therefore, according to the result, family owners in companies with a higher sense of responsibility towards the company's capital can create a safe environment for investors and ensure a return on their investment. The speed of adjustment of financial leverage is when the company adjusts its capital structure and moves toward the optimal leverage it has already targeted and achieved. An et al. (2021) stated a positive relationship exists between foreign institutional ownership and companies' leverage adjustment speed. Foreign institutional investors have an essential regulatory role in reducing agency conflicts between shareholders and managers. According to the theory of dynamic equilibrium, it can be argued that each economic enterprise, considering its characteristics, faces different adjustment costs and, as a result, moves toward its target lever at different speeds. (Salehi et al, 2023 , Choi et al, 2024). Fitzgerald and Ryan (2019) found that small, high-growth, low-dividend-paying companies adjust target leverage faster than large, low-growth, high-dividend-paying companies. Rostami et al. (2022) showed that the short-sightedness of managers has the opposite effect on the speed of adjustment of

financial leverage, so in companies with short-sighted managers, the speed of adjustment of financial leverage decreases towards the optimal lever. Optimal financial leverage is the ratio of debt to assets in which the company's value is at the maximum and the total cost of capital is at the minimum. Therefore, managers continually seek the optimal capital structure to show stakeholders the company's status and performance (Adeneye et al., 2023). Consequently, the optimal capital structure is defined as the target companies' aim to align their capital structure. Based on theoretical concepts, managers should plan the company's optimal capital structure (Rostami et al., 2023; Carvalho et al., 2024).

2.2 Corporate sustainable performance

Corporate sustainability performance includes all activities and strategies that meet the needs of today's stakeholders and, at the same time, preserve the human and natural resources needed in the future (Carmine and De Marchi, 2023; Razzaque et al., 2024). This concept is closely related to corporate social responsibility and is a more significant concept than that. Corporate sustainability is an approach that includes all concepts of corporate social responsibility, corporate citizenship, and even corporate governance (Arduini et al., 2024). Taha et al. (2023) stated that this study shows a significant positive relationship between sustainability performance and profitability. Moreover, liquidity and stock price volatility moderate the impact of sustainability performance on a company's profitability. Based on this approach, companies of any size and operating scale should overcome the limitations by considering the economic complexities in the long term and create positive social and environmental impacts by using innovative solutions. This includes integrating environmental considerations into business activities (Klerk and Muir, 2022). Alareeni and Hamdan (2020) showed that sustainability disclosure positively affects company performance measures.

2.3 Corporate sustainable performance And Speed of adjustment of Capital Structure

A sustainable economy requires businesses whose performance differs from today's and can create more value using fewer resources. Considering these issues, traditional accounting and financial reporting cannot adequately meet the needs of measuring these effects, and the need for broader reporting is felt in organizations, a diverse set of stakeholders, and social, environmental, and economic interests. They follow various factors determining the organization's success (Feng et al., 2020). Giese et al. (2019) showed that changes in a company's sustainability characteristics might be suitable for integrating policy criteria and financial analysis. Sustainability is the ability of something to remain stable for a long time or indefinitely based on performance in these four key areas. Systematic sustainability reporting helps organizations measure the impacts they create or experience, set goals, and manage change. Organizations publish sustainability reports detailing their daily activities' economic, environmental, and social effects. According to previous studies in developed countries, Yoon et al. (2018) showed that sustainability performance positively and significantly affects a company's market. Nonetheless, the impact of sustainability performance on stock price may vary based on specific characteristics of the company.

Legitimacy theory plays a decisive explanatory role in explaining the quality of corporate sustainability (Maas et al., 2016). Legitimacy theory assumes that an institution's activities are desirable, appropriate, and worthy within a social structure defined by norms, values, and beliefs. Thus, legitimacy is a fundamental concept upon which organizations depend for survival. This theory assumes that economic, environmental, and social information are closely connected, and in response to the information and factors of corporate sustainability and its activities, they give legitimacy (Daugaard et al., 2024). Kanadlı et al. (2022) stated that boards of directors who have realized independence of perspective focus on maximizing shareholder profits at the expense of corporate

sustainability considerations. Female directors employing a paradoxical framework can encourage boards to address economic, environmental, and social sustainability issues in their decision-making processes. Sustainability performance enables companies to have higher stability and credit image, so companies with higher corporate sustainability performance and protect the rights of the environment, society, and stakeholders will undoubtedly have more increased access and lower costs than competitors. When acquiring debt financing, these companies can swiftly adjust their financial leverage ratio toward optimal levels (Adeneye et al., 2023). Therefore, according to the stated contents, the hypothesis is presented as follows:

H1: Corporate sustainability performance has a positive and significant effect on the speed of adjusting the capital structure towards the target capital structure.

3. Research methodology

Due to the existence of basic theoretical foundations related to the investigated variables, in terms of the purpose of implementation, the current research is among applied research, and in terms of the implementation method, due to not examining the effect of changing one (independent) variable to measure its impact on another (dependent) variable but reading the variables as they are and without manipulating them, are categorized under descriptive-causal research. Also, due to the historical and post-event nature of the data required for the research, the library and archival methods were used to collect the necessary data to test the research hypotheses.

Due to the ease of access and reliability, the statistical population of this research includes all listed companies on the Tehran stock exchange, after excluding the companies with the end of the financial period other than the end of March and the companies whose financial period during the research period, companies with insufficient information to achieve comparability, as well as investment companies and banks and insurance companies, to ensure the homogeneity of the required data due to the different nature of the activities and reports of recent companies, have changed the information of 136 companies according to the screening pattern. The systematic selection and their data were collected to obtain a sufficient sample as in similar studies for 13 years from 2010 to 2022. Combined data, applying time and place dimensions across different periods, has provided the researcher with more comprehensive and reliable information. The generalized method of moments (GMM) has been used to test the research hypotheses. It should be noted that OLS estimators are no longer compatible when the dependent variable appears as an interval on the model's right side. GMM estimation should be based on dynamic panel models. To estimate the model using this method, it is necessary to specify the instrumental variables used first. The consistency of the GMM estimator depends on the validity of the assumption of serial non-correlation of the error sentences and the instruments, which can be done by Arellano and Bond (1991) and Sargan tests, which check the validity of the instruments. Serial correlation test of error sentences tests the existence of second-order serial correlation in first-order differential error sentences. Failure to reject the null hypothesis of both tests (serial correlation of Khata and Sargan sentences) provides evidence for the assumption of no serial correlation and the validity of the tools. The GMM estimator is consistent if there is no second-order serial correlation in the error terms of the first-order differential equation. Hypothesis testing was done using Eviews 12 software and appropriate statistical methods to finalize hypotheses. Table 1 presents the method of screening the statistical population of the research.

Table 1. The screening of the statistical population

The statistical population in 2022		**577**
Deductible: inactive companies	-193	
Deductible: Companies that have stock trading suspension	-33	
Deductible: Companies that have changed the financial period	-67	
Deductible: Companies that entered the stock market during the research period	-99	
Deductible: investment companies, banks and holdings	-49	
The final sample of the research		136

3.1 Regression model

Following Abuhommous (2021), the following mathematical model has been used to investigate the impact of sustainability performance on the speed of capital structure adjustment.

$$\mathrm{LEV}_{it} = \alpha + (1 - \lambda)\mathrm{LEV}_{it-1} + \emptyset_1 CSP_{it} + \emptyset_2 CSP_{\ it} \times \mathrm{LEV}_{it-1} + (\lambda\psi)\mathrm{Zit} + v_{it}$$

3.2 How research variables are operationalized

3.2.1 Dependent variable: speed of adjustment of Capital Structure

In many studies measuring the speed of adjustment, the partial adjustment model is used to measure the speed of lever adjustment (Öztekin, 2015; Flannery, Rengan, 2006). In the partial adjustment model, actual and optimal leverage should be measured in the first step. However, since optimal commercial credit cannot be measured directly, its value must be obtained by replacing other variables. In this research, those apparent characteristics of the company that influence financing decisions are considered, and other characteristics, such as the economic situation and unobservable (uncontrollable) effects that affect financing decisions and are not easily measured, are considered errors. The estimator is considered. The optimal commercial credit is estimated with the help of the following model. According to the research of Abuhommous (2021), the phenomenon of reversion to the mean regarding the leverage ratio of companies has been investigated by calculating the following model.

$$\mathrm{LEV}_{i,t} - \mathrm{LEV}_{i,t-1} = \lambda(LEV^*_{i,t} - \mathrm{LEV}_{i,t-1}) + u_{it}$$

LEV ∗ i,t is the firm's target capital structure in year t. (λ) the unobserved adjustment speed toward the target is the gap between the target and the current lever. The target leverage (LEV∗ i,t) is unobservable but can be estimated with the following model:

$$LEV^*_{i,t} = \beta' x_{it-1} + u_{it}$$

Where Xi,t-1 is the vector of explanatory variables determining the target's capital structure. According to previous studies, the determining factors include:

1. Company value (Q): equivalent to the ratio of the total market value of shares and the book value of liabilities to the book value of assets.
2. Fixed assets ratio (TANG): equivalent to the ratio of fixed assets to total assets.
3. Profitability (PROF): equivalent to the net profit ratio to total assets.
4. Firm size (SIZE): the natural logarithm of total assets at the end of the period.
5. Firm age: the natural logarithm of the difference between the year of establishment and the desired year.

The optimal capital structure can be calculated using the second model by placing the company's characteristics in the first model.

By placing the target capital structure ratio LEV*i,t in equation (2) and some algebraic calculations, equation (5) is obtained, which is used in practice to measure the speed of lever adjustment:

$$\mathrm{LEV}_{i,t} = (1-\lambda)\mathrm{LEV}_{i,t-1} + (\lambda\beta)x_{it-1} + \alpha i + \delta t + u_{it}$$

3.2.2 The dependent variable of the research: corporate sustainability performance (CSP)

According to Ng & Rezaee (2015), to measure corporate sustainability performance through a set of strengths and weaknesses or concerns using a social rating checklist for all seven dimensions, including social, governance, environment, employee relations, quality Product, human rights, and diversification are classified based on the five dimensions of corporate sustainability, including economic, governance, social, ethical, and environmental domains. In each area, criteria were determined as strengths and weaknesses; if the company under investigation has strengths, the code is (1). Otherwise, it is (0); if the company has weaknesses, the code is (1). Otherwise, it will be (0). The subsets of these dimensions and the checklist, according to Ng & Rezaee (2015), Table 2 are as follows:

Table 2. Different aspects of the company's sustainability performance, along with its strengths and weaknesses

Aspects		Strengths	Weaknesses
Social (SOC)	Social communications	1) Aid to charities, 2) Aid to charities outside Iran, 3) Housing support program, 4) Education support program.	1) negative economic effects, 2) tax problems.
	Diversity	1) The use of female or minority executive directors; 2) The use of women, minorities and disabled people as members of the board of directors; 3) Benefits outside the company for children, the elderly or leisure time; 4) Female and minority employees, 5) The employment of employees' veteran and disabled	1) court problems, 2) not having women on the board of directors.
Governance (GOV)		1) granting bonuses to senior managers, 2) the company owns 20 to 50% of another company's shares, and 3) high transparency.	1) conditional audit opinion, 2) transparency problems.
Ethical	Staffs' relations	1) consideration of non-cash benefits, 2) cash distribution of income, 3) employee engagement, 4) retirement benefits, 5) a strong health and safety program.	1) reduction of the workforce, 2) payment of health and safety violations, and 3) weakness in retirement benefits.
	Human rights	1) friendly relations with local people, 2) proper disclosure of the rights of employees and workers.	N/A
Environment (INV)		) useful products and services, 2) preventing pollution, 3) Using recyclable materials in the production process, 4) Saving energy, 5) Receiving an award and commendation in the field of environment, 6) Maintaining property, machinery and equipment, 7) Obtaining the ISO 14001 certificate by the company for the company's management systems.	1) creation of hazardous wastes, 2) legal issues, 3) ozone-depleting chemicals, 4) producer of agricultural chemicals, 5) climate change.
Economics (ECO)	Product quality	1) long-term quality of products and services, 2) research and development/innovation, and 3) benefits of tough economic conditions.	1) Fines related to product safety, 2) Payment of crimes or lawsuits related to contracts, marketing, advertising methods, etc.

To calculate the sustainability performance of each company, the weak points are subtracted from the strong points, and the score of five dimensions (social, governance, ethical, environmental, and economic performance) is calculated. To calculate the total corporate sustainability score, the following relationship is used:

$$CSP = \sum(\text{strengths - weaknesses})$$

4. Research findings

The research findings include descriptive and inferential statistics, which are first presented in Table 3 descriptive statistics.

Table 3. The descriptive statistics of quantitative research variables

Variable	Sign	Mean	Max.	Min.	Standard deviation	Skewness	Longines
Financial leverage	LEV	0.550	0.990	0.094	0.200	-0.031	2.510
Corporate sustainability performance	CSP	6.440	20.000	-4.000	2.650	0.920	6.930
Company value	Q	2.490	15.030	0.910	2.310	3.330	16.180
Fixed asset ratio	TANG	0.260	0.770	0.024	0.180	0.850	3.060
Profitability	PROF	0.140	0.600	-0.230	0.140	0.530	3.620
Firm size	SIZE	14.690	20.220	10.220	1.730	0.690	3.580
Firm age	Age	3.600	4.260	2.070	0.390	-0.740	2.900

Table (3) shows the descriptive statistics of the research variables. Descriptive statistics shows the amount of data dispersion, and mean and standard deviation are two important factors in descriptive statistics. In the above table, the cumulative average of the companies' capital structure with the value (0.55) shows that most of the data is around this point, and on average, half of the companies' assets are debt. The average value of profitability is about (0.14), which indicates that companies have experienced profitability in this range on average, and the minimum value of this group shows that with the value of (-0.23), some companies have losses. There have been ten. The highest standard deviation belongs to the sustainability performance of companies with a value of (2.65), and the lowest belongs to the fixed assets ratio (0.18).

4.1 The result of the research hypothesis test

Table 4. The results of the research hypothesis test

$$LEV_{it} = \alpha + (1 - \lambda)LEV_{it-1} + \emptyset_1 CSP_{it} + \emptyset_2 CSP_{it} \times LEV_{it-1} + (\lambda\psi)Zit + v_{it}$$

The dependent variable: financial leverage adjustment speed

Variables	Sign	Coefficients	Standard error	t statistic	Significance
Financial leverage of the previous period	LEV_{t-1}	0.400	0.025	16.140	0.000
Corporate sustainability performance	CSP	-0.004	0.004	-1.110	0.260
Interactive coefficient	$LEV_{t-1} \times$ CSP	-0.058	0.020	-2.880	0.004
Company value	Q	2.490	15.030	0.910	2.310
Fixed asset ratio	TANG	0.260	0.770	0.024	0.180
Firm age	Age	-0.140	0.600	-0.230	0.140
Profitability	PROF	0.007	0.002	2.920	0.003
Firm size	SIZE	0.019	0.010	1.900	0.056

The estimation results of the model in Table (4) show that the speed of adjustment of capital structure in the sample companies is about 60%, which indicates that the companies, on average, try

to reduce about 60% of the capital structure deviation every year. Financial coverage of optimal leverage. Additionally, the interaction coefficient (-0.058) indicates that corporate sustainability performance enhances capital structure adjustment speed at a significance level of less than 5% (p-value = 0.004). Therefore, the research hypothesis is not rejected at the 5% error level. According to the results, companies with higher sustainability performance can achieve optimal financial leverage faster than others. Company size (0.056) and profitability (0.003) significantly affect the dependent variable of the research at a significance level of 5 and 10 percent, respectively.

Table 5. The results of Arellano Bond and Sargan-Hansen tests

Tests	Test types	Test statistic	Significance
Validity of tools	Sargan-Hansen statistic	35.021	0.130
Autocorrelation level (first interval)	Arellano-Bond statistic	-16.430	0.000
Autocorrelation level (second interval)	Arellano-Bond statistic	0.406	0.680

Table (5) presents the results of the supplementary analyses. The generalized moments (GMM) method has been used to test the research hypotheses. It is important to note that OLS estimators are no longer appropriate when the dependent variable is specified as an interval on the right-hand side of the model. GMM estimation should be based on dynamic panel models. To estimate the model using this method, it is necessary to specify the instrumental variables used first. Estimator compatibility (GMM) depends on the validity of the assumption of serial non-correlation of error sentences and instruments, which can be done by Arellano and Bond (1991) and Sargan tests, which check the validity of the instruments. Serial correlation test of error sentences tests the existence of second-order serial correlation in first-order differential error sentences. Failure to reject the null hypothesis of both tests (serial correlation of Khata and Sargan sentences) provides evidence for the assumption of no serial correlation and the validity of the tools. The GMM estimator is consistent if there is no second-order serial correlation in the error terms of the first-order differential equation.

5. Conclusion

This study investigates the effect of corporate sustainability performance on the speed of capital structure adjustment. Since the capital structure serves as the foundation for a company's continued operations regarding its capital supply, it is crucial to address the factors influencing it. Determining the optimal capital structure is one of the primary responsibilities of company managers. The optimality of financial leverage is critical because it influences the company's expected risk and return. While optimal leverage is shaped by company-specific and market risks, both over-leverage and under-leverage can expose the company to significant risks. Optimum leverage can bring maximum value to shareholders, so companies should approach the level of their leverage to the optimal leverage as quickly as possible. Therefore, companies will consider the costs of adjusting the capital structure and whether it is aligned with the company's interests. Sometimes, this needs to be included due to the high costs. Over-leveraged companies have advantages such as a tax shield. Over-leveraged companies benefit from advantages such as tax shields but face an increased risk of financial distress. Conversely, under-leveraged companies miss these benefits but reduce their financial risk. According to the trade-off theory, optimal leverage balances these extremes, maximizing the company's value.

Corporate sustainability performance is measured across three dimensions—economic, social, and environmental—which reflect a company's responsibilities toward society and stakeholders. Companies with better sustainability performance perform better than their stock market competitors and accounting performance in the long term. These companies are less vulnerable to external shocks

that impact value creation and experience lower levels of risk. Therefore, increasing sustainability performance is of great importance. The statistical results showed that corporate sustainability performance directly affects the speed of lever adjustment. Sustainability is a broad concept encompassing various ideas, including companies' responsibilities toward stakeholders and society. It can be analyzed through sustainable competition, sustainability reporting, and social sustainability. Currently, the company's sustainability performance is measured in three economic, social, and environmental dimensions, which refer to the responsibility of companies towards society and stakeholders. Companies with better sustainability performance will perform better than their competitors in the stock market and accounting performance in the long term, and their access to financing sources will be easier. Therefore, increasing sustainability performance is essential because this factor can significantly impact the company's access to financing sources and ultimately lower capital costs. When companies bind themselves to various dimensions of corporate sustainability performance from social, economic, governance, and other aspects, and because this is an essential overall combination of managers' responsibility towards stakeholders and society, companies with More access to financing at a lower cost due to high stability in performance and obtaining a higher credit rating, so they can adjust their leverage ratio as quickly as possible towards the optimal capital structure and use its benefits. The results obtained complement the results of studies such as Adeneye et al. (2023), Abuhommous (2021), and Rostami et al. (2022).

6. Practical implications

- Since corporate sustainability has been the focus of managers in the last decade, it is suggested that the stock exchange organization, taking into account the mechanism, emphasizes the importance of this matter by requiring companies to disclose matters related to corporate sustainability in such a way. It shows that every year, a point is assigned to the performance of corporate sustainability, which leads to the motivation of the managers to improve the factors related to this factor.

- Since the results showed that corporate sustainability performance impacts the central pillar of capital decisions (financial leverage) and its adjustment, it is suggested that the managers and significant shareholders adopt a mechanism to improve corporate sustainability performance to grow the image. Companies can avoid financial crises by adjusting the lever towards the target lever.

- To invest in the company, the shareholders can understand the importance of the interests of the shareholders and the company managers by examining the issues related to the level of corporate sustainability performance disclosure and experience a safer investment with less risk.

Future researchers are suggested to examine the research topic in various industries to determine the multiple aspects, and they can also investigate the performance level of corporate sustainability and the level of shareholder loyalty.

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IJAAF; Vol. 9, No. 2, Spring 2025, Serial 31

Iranian Journal of
Accounting, Auditing & Finance

Ferdowsi University of Mashhad

Quarterly

RESEARCH ARTICLE

The Effect of Organizational Culture on Implementation of Accounting Information Systems with the Mediating Role of Types of Capital

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How to cite this article:
Hassoon Mozan Moza, S. , Moradi, M. and Salehi, M. (2025). The Effect of Organizational Culture on Implementation of Accounting Information Systems with the Mediating Role of Types of Capital. Iranian Journal of Accounting, Auditing and Finance, 9(2), 57-76. doi: 10.22067/ijaaf.2025.45707.1492
https://ijaaf.um.ac.ir/article_45707.html

ARTICLE INFO

Article History
Received: 2024-05-07
Accepted: 2024-09-10
Published online: 2025-04-15

Keywords:
Accounting Information Systems, Human Capital, Intellectual Capital, Organizational Culture, Social Capital

Abstract

This paper primarily investigates the pivotal role of organizational culture in implementing accounting information systems. The study also explores the mediating role of various types of capital, including intellectual, social, human, and spiritual capital. The collected data are analyzed through a questionnaire. 191 participants have completed questionnaires. SPSS, Stata, and SmartPLS software are used for data analysis, and hypotheses are checked using various statistical methods. The results showed that organizational culture is a factor in improving the implementation of accounting information systems. Intellectual, human, and spiritual capital mediates the relationship between organizational culture and implementation, but social capital does not influence this relationship. This study has investigated the effect of organizational culture on the implementation of accounting information systems. The findings, which underscore the importance of intellectual, human, and spiritual capital in mediating this relationship, while social capital was found to have no influence, provide a robust foundation for further research and practical applications in the field. This research provides valuable insights into the complex interplay between organizational culture, capital types and the implementation of accounting information systems, reassuring the academic community of the soundness of the research.

https://doi.org/10.22067/ijaaf.2025.45707.1492

NUMBER OF REFERENCES
57

NUMBER OF FIGURES
1

NUMBER OF TABLES
15

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

One of the critical challenges regarding organizational health is related to information flow (Chen, 2022). This problem has become particularly important because information processes show a quantitative and qualitative change in the cognitive structure that affects the knowledge of the organization's people (Chión et al., 2020). Therefore, the line between knowledge and ignorance lies in the privilege of information, and whoever has more information is more capitalist because information technology is a business of knowledge and information (Khan et al., 2020). Good information management and activities related to the management of information backgrounds improve organizational efficiency (Kwarteng et al., 2022). Considering the impact of information on activities and decisions, organizational elements seek to understand the value of information. Perceived value is the basis of many behaviors and includes the action and reaction between user mindsets and the characteristics of products and services (Namazi and Rezaei, 2023); the results of previous studies indicate that perceived value itself is a factor that creates satisfaction and the continuation of behavior (Napitupulu, 2023). According to Nuryanto et al. (2020), the value of information is the degree of influence it has on planning. However, estimating it generally without considering the knowledge related to tasks and time is not easy. The value of information is defined by the consequences of a choice in uncertain situations (Thuneibat et al., 2022). In other words, individuals may be willing to pay for information depending on the degree of uncertainty and risk they perceive. They may pay more for access to additional or improved information. Therefore, the perceived value of information is equal to the expected benefits of obtaining information and depends on factors such as the perceived uncertainty of decision-makers, the cost of using information, and the value of alternatives. It depends. From the perspective (Upadhyay and Kumar, 2020), the perceived value of information is the extent to which the user considers the information valuable and depends on the expertise of the information provider compared to other providers.

Considering the extent of influence and strong dependence of today's society on information and communication technology and information systems (Yoshikuni et al., 2023) and emphasizing it as an inevitable and competitive necessity in the electronic business environment (Afifa et al., 2023), managers' perception of its value has a strong effect on its greater use in the organization (Al-Dmour, 2018). For information systems to be successfully used in the organization, the perceived value of information should be considered. One of the important dimensions in this field is the focus on organizational factors such as human issues, which is emphasized in the work of Hutahayan (2020). Also, the application of information systems can lead to the improvement of organizational performance (Martínez-Peláez et al., 2023). For this purpose, it is necessary to analyze information systems' infrastructure requirements, examine users' needs, and link information technology with the organization's strategy. In addition, increasing employee skills (Raoof et al., 2021) and organizational culture related to information play an important role in creating, sharing, and using information. This aspect of organizational culture is known as "organizational information culture." Paying attention to organizational information culture as an important factor in implementing information systems is important because it is the basis for creating, disseminating, and using information in the organization (Sapta et al., 2021). A similar culture among members can help reduce uncertainty in communication and increase the organization's readiness in complex and changing conditions (Xi et al., 2023). This is one of the most important concerns of information specialists. Also, according to Sunarta and Astuti (2023), weakness in organizational culture is one of the main obstacles to the success of organizations in the digital age because organizational culture shapes the organization's response to challenges (Heryanto and Sudibyo, 2017). As a result, the development of information technology should be in harmony with the organizational culture and move toward facilitating the search and access to information (Haldorai et al., 2022).

Organizational culture refers to a process in which mental resources such as knowledge and information are transformed and used as the primary and material resources (Asiaei et al., 2022). This culture includes shared social patterns that define the organization's behaviors, norms, values, and deep beliefs about the role and importance of information (Hadid and Al-Sayed, 2021). Also, organizational culture provides a framework in which information communication is formed, and the nature of norms and values related to the creation, sharing, and use of information are examined (Khademi and Saberi-Hekami, 2018). From the point of view of Monteiro and Cepêda (2021), organizational culture has dimensions such as information integrity, information sharing, professional activity, transparency, control, and informality of information. In particular, information control and integrity are linked to organizational values that emphasize collecting and using accurate and valid information to control and monitor internal operations. On the other hand, information sharing and professional activity indicate values and norms that strengthen cooperation and innovation in the organization. Information transparency also means the freedom to report errors and failures, while formality refers to the organization's emphasis on using official information versus informal sources (Le et al., 2020). As a result, these dimensions of organizational culture impact the perception of the value of information and the use of information systems. More simply, in organizations where attitudes and norms are based on the value of information, people will be more willing to use information. This culture will strengthen positive attitudes towards information. Since organizations generate a large amount of data during their activities, the management and proper use of this data requires the use of information systems and information technologies. However, for these systems to properly achieve their goals, the factors influencing the use of information should be examined. Research shows that organizational information culture is a new approach to information management that has been less studied. Most of the studies have focused on organizational culture and have mostly focused on evaluating the success of information systems (Srisathan et al., 2020).

Ardianti et al. (2023) showed that managers use information technology for an average of 10 hours per week and consider information systems valuable for their decisions. These managers, especially at the operational level, have valued computer-based information systems for providing helpful information and assisting in effective decision-making. Afifa et al. (2023) also showed that organizational culture is vital in understanding and accepting new technologies, especially in knowledge management and information and communication technology. AI-Matari et al. (2022) also found that although information policies and organizational culture are developed separately, they are closely related. The perceived value of information depends on factors such as the speed, repetition, and accuracy of information providers' responses, and the information seeker's goals (such as learning or decision-making) can moderate this relationship. Due to the high volume of information and data in today's business world, new information technologies help organizations, primarily institutionally owned companies, to store and process information effectively and make better decisions (AI-Hashimy et al., 2022). If accounting information systems cannot provide fast and timely information, these companies will not be successful in today's competitive and risky environment. To face these challenges, companies should benefit from various capital techniques to provide timely and economic financial information and improve their information systems and intellectual capital (Hutahayan, 2020). Business intelligence is how large organizations, such as institutionally owned companies, collect, analyze, and distribute information from internal and external sources to make better decisions. In this regard, different types of capital help companies provide high-quality and timely information for their strategic decisions, reduce risks, and create competitive advantages (Sumardjo and Supriadi, 2023). The support of senior managers and the simultaneous use of information systems and intellectual capital play an important role in the success of this process. As a result, this research investigates the effect of types of capital on the relationship between organizational culture and the

implementation of accounting information systems. The general result of the review of the few existing related backgrounds is that organizational culture can be an empowering platform for using the results of information technology, knowledge management, and information systems to improve organizational performance, intellectual capital, and job satisfaction. Meanwhile, organizational culture is a multi-dimensional and complex issue, and different levels can be seen in different organizations. These factors justify further studies in this field. Therefore, according to the above, this study examines whether organizational culture affects the information system and whether types of capital mediate the relationship between organizational culture and the information system.

2. Theoretical principles and hypothesis development

2.1 The relationship between organizational culture and the implementation of accounting information systems

Organizational culture is one of the critical success factors of projects that deal with organizational changes (Abadiyah et al., 2020). A strong organizational culture can play a primary role in creating motivation and cooperation among employees. A dynamic and robust culture shares the organization's fundamental values (Bhatti et al., 2020). Studies have shown that the atmosphere of relationships between employees and the existing issues governing the organization significantly impact the implementation of information systems. When the organization is involved with cultural problems, the employees' resistance causes the system to be abandoned entirely or implemented with reforms and without the support of much planning (Faeq and Ismael, 2022). A study shows that one of the reasons for many failures in implementing the organization's resource planning system is the need for more attention to the organizational culture. Today, many companies need to pay more attention to the organizational culture when implementing their resource planning system. Both in the implementation phase of the ERP system and its upgrade phase, paying attention to the organizational culture, especially risk-taking indicators, and involving users are vital and important variables (Bhatti et al., 2020). The studies that have dealt with the issue of culture and ERP systems can be divided into two categories; the first category is the studies that have investigated the national culture, and the other category is the studies that have dealt with the field of organizational culture. to (Ismanto et al., 2020). He pointed out that they will not be addressed because they are outside the focus area of this research.

Kordab et al. (2020) found that certain aspects of culture have evolved along with the technology of organizational culture, and the culture of organizational culture can explain why a system is adopted at a mediating level.

Lei et al. (2020) showed that people in urban areas emphasize using official information sources, while in rural communities, the emphasis is on verbal communication and informal information exchange. In addition, geographic dispersion, lack of awareness about information and information literacy, lack of alignment of information services with needs, financial and human barriers, and lack of appropriate information policy are among the most critical challenges related to the organizational culture of Maldives. Muafi et al. (2020) listed the characteristics of four types of organizational culture: result-oriented, rule-oriented, relationship-oriented, and risk-oriented. They believe that organizational culture is related to the organization's effectiveness. Nhon et al. (2020) showed a positive and significant relationship between the formal training of employees and the self-perceived level of project management characteristics. Pathiranage et al. (2020) found that the groups and individuals of these Dutch organizations work well together, and information systems management and organizational culture are related. The research results strongly correlate organizational culture variables and information systems management. Shahzad et al. (2023) found that managers prefer internal-personal information sources. In addition, the ranking of information sources is different

according to managers' union affiliation.

Yang et al. (2021) showed that organizational culture affects the general way of information management. Since investing in information systems is vital to facilitate absorbing and managing information, organizations should develop an information culture to develop electronic government and create, use, and manage information. Andrej et al. (2023) showed that between risky organizational culture and externalization of knowledge. There is a significant relationship between rule-based organizational culture and knowledge synthesis, result-oriented information culture and knowledge internalization, and relationship-oriented organizational culture and knowledge socialization. Saeidi et al. (2021) found that among the six dimensions of information culture based on Chu's framework, three of them, including integrity, professional activity, and informality, flow among the studied institutions. Meanwhile, there is a relationship between the dimension of organizational culture integration with job satisfaction, leadership style, and performance self-expression. Dana et al. (2021) found that organizational culture, as a valuable component of strategic information management, introduces a framework for developing information management strategies in business. They believe that the information culture of the organization's managers and employees significantly impacts solving information-related problems. Therefore, the first hypothesis is presented as follows:

H1: There is a significant relationship between organizational culture and implementing accounting information systems.

2.2. The relationship between organizational culture and the implementation of accounting information systems with the mediating role of types of capital

Types of capital affect the influence and power of companies. Companies with substantial human and intellectual capital have particular sensitivities due to the different nature of their activities, and the discussion of stakeholder theory is more prominent in them. In other words, in these companies, discussing the theory of stakeholders is more important than the theory of agency. Intellectual capital plays a vital role in the success of companies (Alawaqleh et al., 2021). Intellectual capital is a set of internal factors directly affecting the organization, especially listed companies (Anning-Dorson, 2021). Al-Omoush et al. (2022) showed that the management of intellectual resources, which is the title of the main field of management accounting studies, has emerged because intellectual capital and management accounting are mixed. In fact, according to the informational and managerial role of accounting, management has shown many reasons regarding the relationship between management accounting and various indicators of intellectual capital. It helps the primary value-creation process. The management accounting system designs a set of financial and non-financial management indicators to achieve the specific strategies and goals of the companies by combining the existing knowledge and new knowledge, as well as the available gaps for exploiting and using new knowledge. It is identified as increasing the social capital portfolio and improving intellectual capital indicators in high-risk and competitive conditions (Phornlaphatrachakorn and Kalasindhu, 2021). Al-Omoush et al. (2022) considered intellectual capital as a factor that is affected by anything and affects anything. Alassaf et al. (2020) showed that accounting information systems support the development of intellectual capital to improve its indicators (human capital, intellectual capital, and social capital. Ashok et al. (2021) showed a significant positive relationship between the company's intellectual, human, and intellectual capital indicators in improving accounting information systems. Baronian (2022) showed significant relationships between the stages of the social capital process and the indicators of accounting information systems.

Social capital involves acquiring, managing, and analyzing massive amounts of data about the company's stakeholders and existing relationships. Through social capital, companies can use the

information systems provided most effectively to obtain timely and quality information for decision-making, and by reducing existing risks and threats, competitive advantages are created (Lutfi et al., 2022). Social capital is closely related to management accounting systems as a data analysis source. Both play a role in improving the indicators of accounting information systems with their information perspective. The most important common point of human and spiritual capital and social capital is the subject of information and decision-making. The breadth and age of intellectual capital mean it can use accounting information systems to facilitate critical tasks and improve companies by modernizing the organizational culture and accounting information systems (Cadden et al., 2020).

Cui et al. (2022) considered intellectual capital a factor that is affected by anything and affects anything. Dahiyat et al. (2023) showed that organizational culture increases the expertise of management accountants due to the introduction of new and advanced decision-making techniques. On the other hand, it has a promoting effect on increasing management accounting techniques. Dhar et al. (2022) showed that business intelligence is related to the decision-making process based on environmental conditions in large companies.

Therefore, the second to fifth hypothesis is proposed as follows:

H2: Intellectual capital mediates the relationship between organizational culture and the implementation of accounting information systems.

H3: Social capital mediates the relationship between organizational culture and the implementation of accounting information systems.

H4: Human capital mediates the relationship between organizational culture and implementing accounting information systems.

H5: Intellectual capital mediates the relationship between organizational culture and the implementation of accounting information systems.

3. Research methodology

In the following, the collected data are analyzed through the questionnaire to examine the research model, discover the relationship between the variables, and test the research hypotheses. SPSS, Stata, and SmartPLS software will be used for data analysis, and hypotheses will be checked using various statistical methods.

4. Findings

4.1 Descriptive statistics

First, descriptive statistics of demographic questions are presented in Table (1). 191 participants completed the questionnaires. Most of the respondents were men, and most of them had master's degrees. Most people have an accounting position with 5 to 10 years of experience.

The designed questionnaire consists of 6 main sections, including organizational culture, intellectual capital, human capital, social capital, spiritual capital, and implementation of accounting information systems. The options before each question include completely agree, agree, neither agree nor disagree, disagree, and completely disagree, coded with numbers 1 to 5.

Table 1. Frequency of demographic data

	No.	Frequency		No.	Frequency
Gender			**Position**		
Female	30	15.71	Accounting	98	51.31
Male	161	84.29	Financial manager	76	39.79
Education			University professor	17	8.90
Less than a bachelor's degree	12	6.28	**Work experience**		
Bachelor's	76	39.79	Less than 5 years	30	15.71
Master's degree	93	48.69	5-10 years	90	47.12
Ph.D	10	5.24	11-20 years	40	20.94
			21-25 years	16	8.38
Total			Above 25 years	15	7.85

4.2. Inferential statistics

Cronbach's alpha coefficient, composite reliability coefficient, and average extracted variance were checked to check the validity and reliability of the research questionnaire. The alpha coefficient for the designed questionnaire is equal to 0.911, which is in the appropriate range. The average variance index was extracted to evaluate the structure's validity, and the Fornell and Larcker criteria were used. According to table (2), the AVE index for model variables is higher than 0.5; therefore, the convergence validity of the measured model is suitable. Also, to check the goodness of fit indices of measurement models, several methods were used; the summary of these tests and their acceptable ranges are summarized in Table (3). According to these results, it can be concluded that the model fit is suitable for the data, and the results obtained from it can be reliable.

Table 2. Reliability and validity findings of the research

Cronbach's Alpha	Composite reliability coefficient	AVE
0.911	0.862	0.751

Table 3. The goodness of fit criteria

Indicator	Sign	Calculation	Acceptable	Ideal
$\chi 2$ significance	χ^2	<0.002	$0.05 < p \leq 1.00$	$0.01 < p \leq .05$
Optimized chi-square	$\chi 2/df$	2.033	$0 < \chi^2/df \leq 5$	$0 \leq \chi^2/df \leq 3$
Good for him	GFI	0.897	$0.80 \leq GFI < 0.95$	$0.95 \leq GFI \leq 1.00$
Adjusted goodness	AGFI	0.875	$0.80 \leq GFI < 0.95$	$0.95 \leq GFI \leq 1.00$
Root mean square residual	RMR	0.052	$0 < RMR \leq 0.10$	$0 \leq RMR \leq 0.05$
Comparative fit index	CFI	0.903	$0.90 \leq CFI < 0.97$	$0.97 \leq CFI \leq 1.00$
The root mean square of the estimation error	RMSEA	0.048	$0.05 < RMSEA \leq 0.08$	$0 \leq RMSEA \leq 0.05$

The research variables were obtained by averaging the received answers to the questions in their sub-set, whose diagram will be drawn in Figure (1) below. In addition, in Table (4), the main components of the research, the number of questions, Cronbach's alpha, and factor analysis of each part of the questionnaire were also calculated. The questionnaire has a suitable internal structure because Cronbach's alpha is between 0.765 and 0.940. In the following table (5), the descriptive statistics of the variables were calculated.

Since the third option is neither agree nor disagree, a comparison of averages has been made by using a t-test and examining the average of less than three according to the arrangement of answers. According to the result of the t-test presented in Table (6), the null hypothesis of equality and greater than 3 for all the main variables of the research is rejected at the 99% confidence level. Therefore, as was said before, the people participating in the questionnaire significantly agreed with components such as organizational culture, intellectual, human, social, and spiritual capital and implementation. Accounting information systems have expressed.

Table 4. Components: number of questions, Cronbach's alpha and factor analysis results

Components	Questions	Cronbach's Alpha	Factor analysis
Organizational culture	16	0.908	0.877-0.971
Intellectual capital	16	0.891	0.879-0.991
Human capital	16	0.926	0.772-0.954
Social capital	17	0.911	0.874-0.972
Spiritual capital	13	0.936	0.762-0.974
1. Religiosity	4	0.940	0.883-0.928
2. Creativity	4	0.913	0.879-0.979
3. Ethics	3	0.938	0.772-0.974
4. Health	2	0.889	0.835-0.917
Implementation of accounting information systems	10	0.765	0.672-0.971

Table 5. Descriptive statistics of hidden research variables

Variables	Latin	Observations	Mean	Std. Dev.	Min.	Max.
Organizational culture	CUO	191	1.919	0.445	1.000	3.188
Intellectual capital	CAI	191	1.986	0.443	1.000	3.188
Human capital	CAH	191	1.972	0.506	1.000	3.250
Social capital	CAS	191	1.969	0.337	1.235	2.853
Spiritual capital	CAP	191	1.821	0.372	1.000	2.625
1. Religiosity	CAPR	191	1.787	0.487	1.000	3.000
2. Creativity	CAPC	191	1.791	0.449	1.000	2.750
3. Ethics	CAPE	191	1.888	0.428	1.000	3.000
4. Health	CAPH	191	1.819	0.497	1.000	3.000
Implementation of accounting information systems	AIR	191	1.863	0.412	1.100	4.200

Table 6. Comparison of averages

Variables	Latin	Observations	Mean	Difference	t statistic	Prob
Organizational culture	CUO	191	1.919	–1.081	–33.562	0.000
Intellectual capital	CAI	191	1.986	–1.014	–31.646	0.000
Human capital	CAH	191	1.972	–1.028	–28.075	0.000
Social capital	CAS	191	1.969	–1.031	–42.317	0.000
Spiritual capital	CAP	191	1.821	–1.179	–43.805	0.000
1. Religiosity	CAPR	191	1.787	–1.213	–34.459	0.000
2. Creativity	CAPC	191	1.791	–1.209	–37.193	0.000
3. Ethics	CAPE	191	1.888	–1.112	–35.937	0.000
4. Health	CAPH	191	1.819	–1.181	–32.800	0.000
Implementation of accounting information systems	AIR	191	1.863	–1.137	–38.161	0.000

After that, in Table (7), the Pearson correlation coefficient between the hidden components of the research was obtained. The correlation coefficient of the organizational culture variable with the information systems implementation variable (AIR) equals 0.458 at the 99% confidence level. The components of intellectual capital reinforce each other and have a direct and meaningful effect on each other. In the meantime, the effect of these components on spiritual capital (CAP) is such that the most significant effect belongs to creativity (CAPC), ethics (CAPE), health (CAPH), and religiosity (CAPR) with coefficients. The correlation is 0.845, 0.828, 0.792 and 0.740. Capital indices also reinforce each other. The correlation between the four capital indicators is positive and significant at 99% confidence. Among these variables, the highest correlation with the information systems implementation variable (AIR) belongs to human capital (CAH), social capital (CAS), spiritual capital (CAP), and intellectual capital (CAI), with correlation coefficients of 0.533. They have 0.526, 0.474, and 0.388.

Table 7. Correlation matrix of hidden research variables

Cuo	Cai	Cah	Cas	Cap	Capr	Capc	Cape	Caph	Air	
1										Cuo
0.594	1									Cai
0.595	0.577	1								Cah
0.475	0.384	0.628	1							Cas
0.589	0.713	0.615	0.472	1						Cap
0.273	0.625	0.445	0.369	0.740	1					Capr
0.657	0.619	0.654	0.442	0.845	0.502	1				Capc
0.470	0.509	0.445	0.443	0.828	0.446	0.681	1			Cape
0.496	0.526	0.430	0.272	0.792	0.397	0.548	0.565	1		Caph
0.458	0.388	0.533	0.526	0.474	0.500	0.434	0.323	0.260	1	Air

Note: All calculated coefficients are significant at the 99% level.

In Figure (1), the output and the effect of the hidden and apparent variables of the questionnaire according to the previous results to evaluate the views of managers and accountants on the influence of organizational culture as well as the mediating role of intellectual, human, social and spiritual capitals on the implementation of systems Accounting information has been drawn in Iraq. This figure shows that organizational culture positively and significantly affects the implementation of accounting information systems. Similarly, intellectual, human, social, and spiritual capital also positively and significantly affect the implementation of accounting information systems.

In the following, covariance analysis is used when there is more than one independent variable in the Mancova method. To use this method, the normality of the distribution of the variables was checked using the Kolmogorov-Smirnov test. Table (8) shows the results of this test. The null hypothesis of this test is that the variables have a normal distribution. According to the presented results, all the variables have a normal distribution.

Table 8. Normality test of variables

Variables	p-value	Variables	p-value
CUO	0.823	CAP	0.663
CAI	0.798	CHT	0.702
CAH	0.350	AIR	0.909
CAS	0.270		

Another critical assumption of covariance analysis is the homogeneity of regression coefficients. The interaction of the pre-tests with each group's hypotheses was insignificant, indicating the homogeneity of the regression coefficients. As can be seen, the non-significance indicates compliance with the assumption of the regression slope in Table (9), so the assumption F of the homogeneity of the regression coefficients is also established. Considering the establishment of covariance analysis assumptions, this statistical test is allowed.

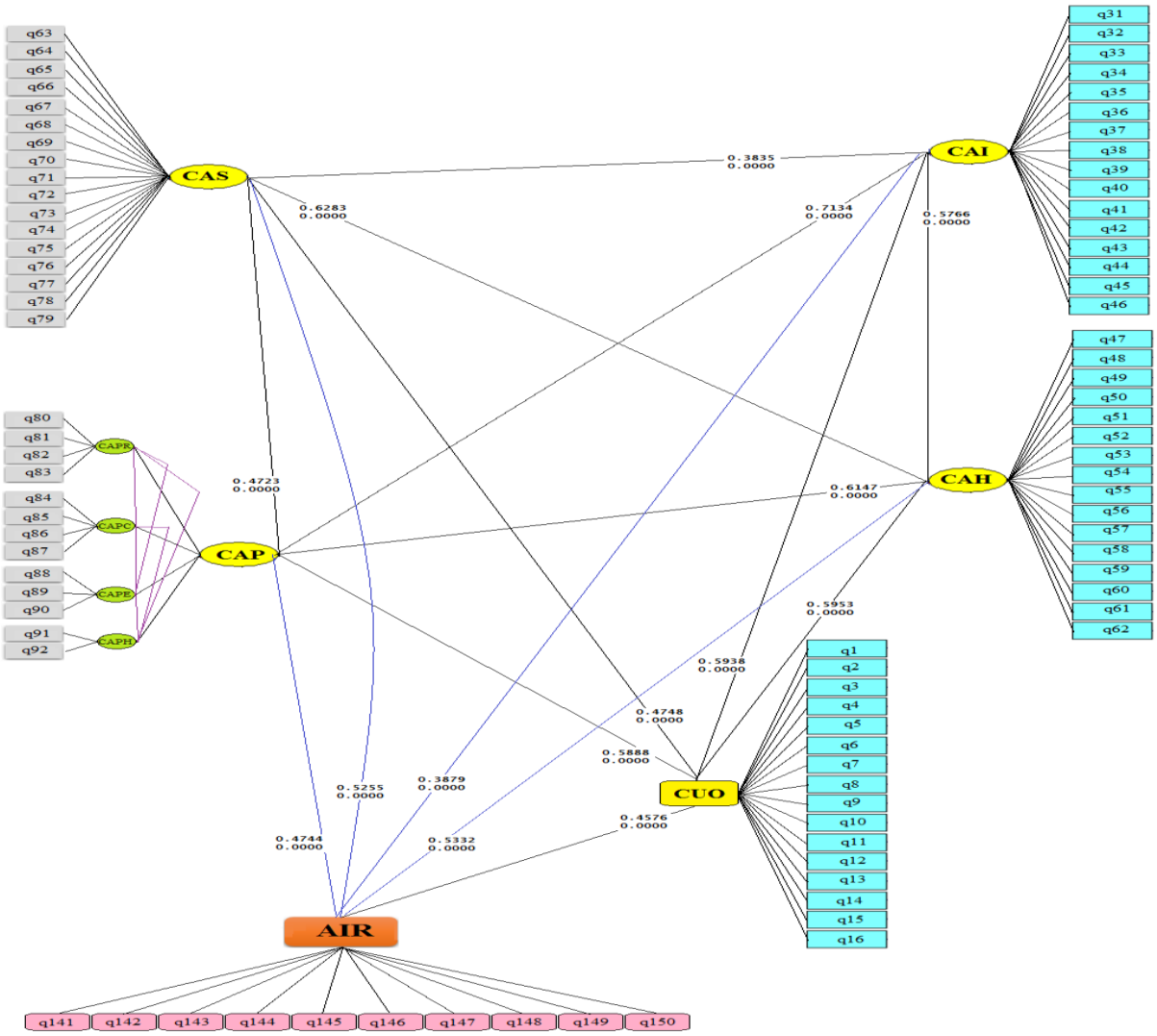

Figure 1. The output and the effect of the hidden and apparent variables

Table 9. Results of regression slope homogeneity test

Statement	Total squares	Mean squares	Degree of freedom	Statistic	Significance
The effect of organizational culture on the implementation of accounting information systems	8.971	8.971	1	0.763	0.623
The effect of intellectual capital on the implementation of accounting information systems	2.170	2.170	1	0.550	0.415
The effect of social capital on the implementation of accounting information systems	10.223	10.223	1	0.621	0.783
The effect of human capital on the implementation of accounting information systems	0.170	0.170	1	0.920	0.352
The effect of intellectual capital on the implementation of accounting information systems	1.400	1.400	1	0.680	0.409

Table (10) results indicate that the necessary conditions for using covariance analysis are met. The results of the one-way covariance test are presented in Table (11). The results of the variance analysis show that the significant value is greater than 0.05, so the research hypothesis cannot be rejected.

Table 10. One-way covariance test results

	Source	Total squares	Mean squares	F statistic	df	Significance	OTA
The effect of organizational culture on the implementation of accounting information systems	Pre-test*error group	8.971	8.971	1	0.763	0.623	0.120
The effect of intellectual capital on the implementation of accounting information systems	Pre-test*error group	2.170	2.170	1	0.550	0.415	0.150
The effect of social capital on the implementation of accounting information systems	Pre-test*error group	10.223	10.223	1	0.621	0..783	0.130
The effect of human capital on the implementation of accounting information systems	Pre-test*error group	0.170	0.170	1	0.920	0.352	0.080
The effect of intellectual capital on the implementation of accounting information systems	Pre-test*error group	1.400	1.400	1	0.680	0.409	0.030

The correlation test results in Table (11) show that the F value at the 99% level is significant for most research hypotheses, including the effect of social, intellectual, and human capital on the implementation of accounting information systems. In addition, the effect of intellectual capital on the implementation of accounting information systems has been accepted at the 95% confidence level.

Table 11. The results of the intergroup effects test

	Total squares	Mean squares	F statistic	Degree of freedom	Significance
The effect of organizational culture on the implementation of accounting information systems	3.689	3.689	2.169	1	0.004
The effect of intellectual capital on the implementation of accounting information systems	11.225	11.225	12.460	1	0.000
The effect of social capital on the implementation of accounting information systems	100.635	100.635	143.322	1	0.000
The effect of human capital on the implementation of accounting information systems	6.752	6.752	9.400	1	0.000
The effect of intellectual capital on the implementation of accounting information systems	4.580	4.580	4.580	1	0.047

After that, the ordinary least squares (OLS) method was used to investigate the effect of hidden variables on implementing information systems more closely. Table (12) shows the effect results, including coefficient and significance level. As it is known, hidden variables, including organizational culture and intellectual, social, human, and spiritual capital, affect the implementation of accounting information systems at the 99% confidence level. Structural equations were used to investigate the interactive effects of these variables following the research hypotheses and consider the demographic variables.

Table 12. The direction of the effect of hidden variables on the implementation of information systems

Conclusion	P-value	Coefficient	Effect direction
Organizational culture affects the implementation of accounting information systems.	0.000	0.423	AIR ← CUO
Intellectual capital affects the implementation of accounting information systems.	0.000	0.361	AIR ← CAI
Social capital affects the implementation of accounting information systems.	0.000	0.612	AIR ← CAS
Human capital affects the implementation of accounting information systems.	0.000	0.434	AIR ← CAH
Intellectual capital influences the implementation of accounting information systems.	0.000	0.525	AIR ← CAP
Intellectual capital mediates the relationship between organizational culture and the implementation of accounting information systems.	0.000	0.124	~~AIR~~ (CAI*CUO)
Social capital mediates the relationship between organizational culture and the implementation of accounting information systems.	0.000	0.177	~~AIR~~ (CAS*CUO)
Human capital mediates the relationship between organizational culture and the implementation of accounting information systems.	0.000	0.141	~~AIR~~ (CAH*CUO)
Intellectual capital mediates the relationship between organizational culture and the implementation of accounting information systems.	0.000	0.152	~~AIR~~ (CAP*CUO)

After that, the structural equation method is used to check the research hypotheses more precisely. Table (13) presents the fitting results separately for intellectual, social, human, and spiritual capitals. In the first model (Model 1), the Cuo variable coefficient at the 99% confidence level equals 0.937. Therefore, organizational culture becomes the factor in improving the implementation of accounting information systems, and the first hypothesis is accepted at the 99% confidence level. In addition, intellectual capital also becomes a factor in improving the implementation of accounting information systems at the 99% confidence level. The coefficient of this variable was equal to 0.668. The interactive variable Cai* Cuo coefficient is also positive and significant. Therefore, the second hypothesis that intellectual capital mediates the relationship between organizational culture and implementing accounting information systems is also confirmed at the 99% confidence level.

In the second model, the coefficient of the Cas variable was obtained at the 99% confidence level, equal to 0.683. Therefore, social capital is also a factor in improving the implementation of accounting information systems. The interactive variable Cas* Cuo coefficient was estimated to be positive but insignificant. Therefore, the third hypothesis is not confirmed. After that, the Cah variable coefficient was obtained at the 99% confidence level equal to 0.537. Therefore, human capital is also a factor in improving the implementation of accounting information systems. Also, the interactive variable Cah*Cuo coefficient is positive and significant. Therefore, the fourth hypothesis, that human capital mediates the relationship between organizational culture and implementing accounting information systems, is also confirmed at the 99% confidence level.

Table 13. Fitting structural equation regressions

	Model 1		Model 2		Model 3		Model 4	
Variable	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**
Cuo	0.937	0.000	0.412	0.001	0.400	0.063	0.573	0.014
Cai	0.668	0.000						
Cai* Cuo	0.312	0.004						
Cas			0.683	0.000				
Cas* Cuo			0.090	0.139				
Cah					0.537	0.006		
Cah* Cuo					0.114	0.000		
Cap							0.738	0.002
Cap* Cuo							0.185	0.038
Gender	0.021	0.787	0.074	0.317	0.073	0.333	0.069	0.379
Education	-0.007	0.874	0.010	0.800	-0.010	0.805	0.052	0.253
Position	-0.052	0.156	-0.061	0.085	-0.051	0.141	-0.083	0.024
Experience	0.022	0.417	0.035	0.163	0.030	0.249	0.022	0.410
Constant	-0.006	0.988		0.479	0.459	0.262	-0.023	0.961

In the fourth model, the coefficient of spiritual capital was fitted at the 99% confidence level equal to 0.738. Therefore, intellectual capital is also a factor in improving the implementation of accounting information systems. The interactive variable Cap* Cuo coefficient is also positive and significant. Therefore, the fifth hypothesis, that intellectual capital mediates the relationship between organizational culture and implementing accounting information systems, is also confirmed at the 95% confidence level. In general, according to the applied regressions, it can be concluded that among the components of capital, spiritual capital and social capital have the greatest effect, and human capital and intellectual capital have the least effect on implementing accounting information systems in Iraq.

In the following, quantile regression has been used to evaluate the coefficients obtained in different percentages of the variable implementation of accounting information systems. In table (14), the coefficient of organizational culture in lower values of AIR is small and becomes more intense with the increase in the implementation of accounting information systems. On the contrary, intellectual capital has a larger coefficient in smaller amounts of accounting information systems implementation. With the increase of the AIR variable, these coefficients become smaller and smaller. Hence, considering that the intensity of the two variables of organizational culture and intellectual capital increase in the opposite direction, the interactive variable Cai* Cuo has the most effect in the middle quartiles and the first quartile at the level of 95% and in the fourth quartile, it is not significant on the AIR variable.

In the second model, the influence coefficient of the social capital variable decreases in the last quartile. The interactive variable Cai* Cuo is also significant and positive in the first two quartiles at 99%. In the last two quartiles, unlike the estimate of the structural equation system. Therefore, social capital mediates the relationship between organizational culture and implementing accounting information systems below the average. The influence coefficient of the human capital variable also increases with the increase in the implementation of accounting information systems.

Nevertheless, human capital mediates the relationship between organizational culture and the implementation of accounting information systems in smaller amounts of accounting information systems implementation. The influence coefficient of intellectual capital also increases in the last quadrants of implementing accounting information systems. Nevertheless, intellectual capital in the last quadrant, unlike the first three quadrants, does not mediate the relationship between organizational culture and the implementation of accounting information systems.

Table 14. The fit of quantile regressions

Variable		25%		50%		75%		100%	
		Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Model 1	Cuo	0.610	0.017	0.670	0.000	0.802	0.000	0.913	0.039
	Cai	0.836	0.000	0.924	0.000	0.638	0.000	0.116	0.575
	Cai* Cuo	0.287	0.029	0.225	0.000	0.347	0.000	0.046	0.720
Model 2	Cuo	0.700	0.000	0.892	0.004	1.045	0.000	1.031	0.000
	Cas	1.213	0.000	1.665	0.000	1.064	0.253	0.801	0.268
	Cas* Cuo	0.400	0.002	0.634	0.005	0.362	0.415	0.592	0.095
Model 3	Cuo	0.323	0.000	0.511	0.000	0.959	0.000	0.749	0.429
	Cah	0.238	0.000	0.759	0.000	1.053	0.000	0.862	0.268
	Cah* Cuo	0.308	0.001	0.435	0.000	0.230	0.000	0.300	0.073
Model 4	Cuo	0.871	0.000	0.706	0.000	1.194	0.001	0.925	0.001
	Cap	0.706	0.000	1.021	0.000	1.473	0.000	1.147	0.044
	Cap* Cuo	0.383	0.000	0.423	0.000	0.579	0.001	0.047	0.673

After that, the impact of sub-indices of spiritual capital, including religiosity, creativity, ethics, and health, on implementing accounting information systems and their mediating role in the relationship between organizational culture and AIR variables were investigated. In Table (15), religiosity and ethics increase the implementation of accounting information systems at the 90% confidence level. Still, they do not affect the relationship between organizational culture and the AIR variable. On the contrary, creativity at 99% confidence and health at 95% confidence are factors in improving the implementation of accounting information systems in Iraq. These variables affect the relationship between organizational culture and AIR variable at the 95% confidence level, and their mediating role is confirmed.

Table 15. Investigating the mediating role of intellectual capital components

	Model 1		Model 2		Model 3		Model 4	
Variable	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Cuo	0.635	0.000	0.805	0.021	0.849	0.031	0.979	0.018
Capr	0.681	0.070						
Capr* Cuo	0.166	0.231						
Capc			0.743	0.010				
Capc* Cuo			0.284	0.015				
Cape					0.631	0.061		
Cape* Cuo					0.258	0.148		
Caph							0.623	0.033
Caph* Cuo							0.319	0.048

5. Discussions and conclusion

Organizational culture includes shared values, norms, and behaviors that are formed in the organization and determine how employees interact with technological changes and innovations (Danish et al., 2021). Organizations with open and innovative cultures are usually more receptive to new technologies encountered, and this makes the accounting information systems to be implemented in a better way. By strengthening cooperation and coordination among organizational members, organizational culture provides the basis for accepting information systems and using them to improve decisions and internal control. In addition to examining the relationship between organizational culture and accounting information systems, this research also examines the role of

capital types in this relationship. For example, intellectual capital, which includes the organization's knowledge, skills, and experiences, can improve the productivity of accounting information systems. Also, social capital can facilitate the successful implementation of systems by strengthening relationships between organization members and creating cooperation networks. Human capital, which includes the development of employees' skills and their empowerment, plays an important role in the adoption and optimal use of these systems. Finally, intellectual capital can also help to better implement accounting information systems by influencing the values and beliefs of employees to strengthen organizational commitment. This type of capital helps to strengthen the sense of belonging and gives meaning to the work in the organization. It can lead to the improvement of interactions between members and increase the effective use of information systems. As a result, investigating the mediating effects of types of capital in the relationship between organizational culture and the implementation of accounting information systems can provide effective solutions to improve organizational performance. The analysis of these relationships shows that organizational culture alone cannot guarantee the success of implementing accounting information systems. However, the mediating role of types of capital is significant. Organizational culture can affect the effective use of existing funds and improve the process of implementing information systems through the synergy of these funds. Therefore, to achieve optimal results, organizations should not only focus on strengthening their organizational culture but also develop their human, social, and structural capital and use them in a coordinated way to implement accounting information systems. The following are the results of the research:

The research results showed a significant relationship between organizational culture and the implementation of accounting information systems. Therefore, organizational culture can influence how information systems are accepted and used in the organization and improve the performance of these systems. When the organizational culture is positive and especially emphasizes innovation, continuous learning, and support for technology, accounting information systems are implemented better. In such environments, employees are more willing to accept technological changes and can more easily adapt to new technologies. This leads to increasing the effectiveness of information systems and improving accounting processes. On the other hand, a negative organizational culture or resistance to change can hinder the successful implementation of accounting information systems. For example, cultures that emphasize strict hierarchies or fear of mistakes and failure may increase employee resistance to technological change and reduce the effectiveness of information systems. Therefore, this result points to the importance of creating and strengthening an appropriate organizational culture to improve the implementation of information systems in the organization. The results of the research are consistent with the results of Pathiranage et al. (2020), who found that groups and individuals in Dutch organizations work well together, that information systems management and organizational culture are related to each other, and the results of Yang et al. (2021) showed that organizational culture affects the general method of information management. Dana et al. (2021) also found that the information culture of managers and employees of the organization greatly impacts solving problems related to information, which is in line with the results of the present study.

The results also show that intellectual, human, and spiritual capital mediates the relationship between organizational culture and the implementation of accounting information systems. In organizations with well-developed intellectual capital, employees have the necessary knowledge and skills to use information technologies. With a better understanding of the benefits and capabilities of accounting information systems, these people can play a key role in adopting and implementing these systems. On the other hand, an open and supportive organizational culture, which emphasizes knowledge sharing and innovation, can contribute to forming strong intellectual capital. In such

organizations, specialized knowledge and professional experiences are constantly shared between individuals and teams, which leads to increased efficiency of information systems. By influencing employees' ability to understand and work with complex technologies, human capital can reduce implementation barriers and allow organizations to use accounting information systems more effectively. In other words, a strong relationship between human capital and organizational culture makes employees more prepared for technology-related changes, facilitating information systems' implementation. With its emphasis on ethical values, intellectual capital can promote transparency, honesty, and trust in information systems, promoting their effective and optimal use. The research results are consistent with the results of Alassaf et al. (2020), who showed that accounting information systems support the development of intellectual capital to improve its indicators (human capital, spiritual capital, and social capital). Also, the results of Ashok et al. (2021) showed a significant positive relationship between the company's investment amount in the indicators of intellectual, human, and spiritual capital in improving accounting information systems. The results of Baronian (2022), who showed significant relationships between the stages of the social capital process and the indicators of accounting information systems, align with the results of the present study.

The results also indicated that social capital does not affect the relationship between organizational culture and the implementation of information systems. In some Iranian organizations, social capital may need to be fully developed or limited to informal relationships and small groups. These limitations can make social capital unable to effectively mediate the implementation of accounting information systems. Especially in work environments where formal and hierarchical relationships prevail, social capital may not act as a facilitating factor in technological change.

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IJAAF; Vol. 9, No. 2, Spring 2025, Serial 31

Iranian Journal of
Accounting, Auditing & Finance

Ferdowsi University of Mashhad

Quarterly

RESEARCH ARTICLE

The Effect of Organizational Culture on Implementation of Accounting Information Systems with the Mediating Role of Types of Capital

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How to cite this article:
Hassoon Mozan Moza, S. , Moradi, M. and Salehi, M. (2025). The Effect of Organizational Culture on Implementation of Accounting Information Systems with the Mediating Role of Types of Capital. Iranian Journal of Accounting, Auditing and Finance, 9(2), 57-76. doi: 10.22067/ijaaf.2025.45707.1492
https://ijaaf.um.ac.ir/article_45707.html

ARTICLE INFO

Article History
Received: 2024-05-07
Accepted: 2024-09-10
Published online: 2025-04-15

Keywords:
Accounting Information Systems, Human Capital, Intellectual Capital, Organizational Culture, Social Capital

Abstract

This paper primarily investigates the pivotal role of organizational culture in implementing accounting information systems. The study also explores the mediating role of various types of capital, including intellectual, social, human, and spiritual capital. The collected data are analyzed through a questionnaire. 191 participants have completed questionnaires. SPSS, Stata, and SmartPLS software are used for data analysis, and hypotheses are checked using various statistical methods. The results showed that organizational culture is a factor in improving the implementation of accounting information systems. Intellectual, human, and spiritual capital mediates the relationship between organizational culture and implementation, but social capital does not influence this relationship. This study has investigated the effect of organizational culture on the implementation of accounting information systems. The findings, which underscore the importance of intellectual, human, and spiritual capital in mediating this relationship, while social capital was found to have no influence, provide a robust foundation for further research and practical applications in the field. This research provides valuable insights into the complex interplay between organizational culture, capital types and the implementation of accounting information systems, reassuring the academic community of the soundness of the research.

https://doi.org/10.22067/ijaaf.2025.45707.1492

NUMBER OF REFERENCES
57

NUMBER OF FIGURES
1

NUMBER OF TABLES
15

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

One of the critical challenges regarding organizational health is related to information flow (Chen, 2022). This problem has become particularly important because information processes show a quantitative and qualitative change in the cognitive structure that affects the knowledge of the organization's people (Chión et al., 2020). Therefore, the line between knowledge and ignorance lies in the privilege of information, and whoever has more information is more capitalist because information technology is a business of knowledge and information (Khan et al., 2020). Good information management and activities related to the management of information backgrounds improve organizational efficiency (Kwarteng et al., 2022). Considering the impact of information on activities and decisions, organizational elements seek to understand the value of information. Perceived value is the basis of many behaviors and includes the action and reaction between user mindsets and the characteristics of products and services (Namazi and Rezaei, 2023); the results of previous studies indicate that perceived value itself is a factor that creates satisfaction and the continuation of behavior (Napitupulu, 2023). According to Nuryanto et al. (2020), the value of information is the degree of influence it has on planning. However, estimating it generally without considering the knowledge related to tasks and time is not easy. The value of information is defined by the consequences of a choice in uncertain situations (Thuneibat et al., 2022). In other words, individuals may be willing to pay for information depending on the degree of uncertainty and risk they perceive. They may pay more for access to additional or improved information. Therefore, the perceived value of information is equal to the expected benefits of obtaining information and depends on factors such as the perceived uncertainty of decision-makers, the cost of using information, and the value of alternatives. It depends. From the perspective (Upadhyay and Kumar, 2020), the perceived value of information is the extent to which the user considers the information valuable and depends on the expertise of the information provider compared to other providers.

Considering the extent of influence and strong dependence of today's society on information and communication technology and information systems (Yoshikuni et al., 2023) and emphasizing it as an inevitable and competitive necessity in the electronic business environment (Afifa et al., 2023), managers' perception of its value has a strong effect on its greater use in the organization (Al-Dmour, 2018). For information systems to be successfully used in the organization, the perceived value of information should be considered. One of the important dimensions in this field is the focus on organizational factors such as human issues, which is emphasized in the work of Hutahayan (2020). Also, the application of information systems can lead to the improvement of organizational performance (Martínez-Peláez et al., 2023). For this purpose, it is necessary to analyze information systems' infrastructure requirements, examine users' needs, and link information technology with the organization's strategy. In addition, increasing employee skills (Raoof et al., 2021) and organizational culture related to information play an important role in creating, sharing, and using information. This aspect of organizational culture is known as "organizational information culture." Paying attention to organizational information culture as an important factor in implementing information systems is important because it is the basis for creating, disseminating, and using information in the organization (Sapta et al., 2021). A similar culture among members can help reduce uncertainty in communication and increase the organization's readiness in complex and changing conditions (Xi et al., 2023). This is one of the most important concerns of information specialists. Also, according to Sunarta and Astuti (2023), weakness in organizational culture is one of the main obstacles to the success of organizations in the digital age because organizational culture shapes the organization's response to challenges (Heryanto and Sudibyo, 2017). As a result, the development of information technology should be in harmony with the organizational culture and move toward facilitating the search and access to information (Haldorai et al., 2022).

Organizational culture refers to a process in which mental resources such as knowledge and information are transformed and used as the primary and material resources (Asiaei et al., 2022). This culture includes shared social patterns that define the organization's behaviors, norms, values, and deep beliefs about the role and importance of information (Hadid and Al-Sayed, 2021). Also, organizational culture provides a framework in which information communication is formed, and the nature of norms and values related to the creation, sharing, and use of information are examined (Khademi and Saberi-Hekami, 2018). From the point of view of Monteiro and Cepêda (2021), organizational culture has dimensions such as information integrity, information sharing, professional activity, transparency, control, and informality of information. In particular, information control and integrity are linked to organizational values that emphasize collecting and using accurate and valid information to control and monitor internal operations. On the other hand, information sharing and professional activity indicate values and norms that strengthen cooperation and innovation in the organization. Information transparency also means the freedom to report errors and failures, while formality refers to the organization's emphasis on using official information versus informal sources (Le et al., 2020). As a result, these dimensions of organizational culture impact the perception of the value of information and the use of information systems. More simply, in organizations where attitudes and norms are based on the value of information, people will be more willing to use information. This culture will strengthen positive attitudes towards information. Since organizations generate a large amount of data during their activities, the management and proper use of this data requires the use of information systems and information technologies. However, for these systems to properly achieve their goals, the factors influencing the use of information should be examined. Research shows that organizational information culture is a new approach to information management that has been less studied. Most of the studies have focused on organizational culture and have mostly focused on evaluating the success of information systems (Srisathan et al., 2020).

Ardianti et al. (2023) showed that managers use information technology for an average of 10 hours per week and consider information systems valuable for their decisions. These managers, especially at the operational level, have valued computer-based information systems for providing helpful information and assisting in effective decision-making. Afifa et al. (2023) also showed that organizational culture is vital in understanding and accepting new technologies, especially in knowledge management and information and communication technology. AI-Matari et al. (2022) also found that although information policies and organizational culture are developed separately, they are closely related. The perceived value of information depends on factors such as the speed, repetition, and accuracy of information providers' responses, and the information seeker's goals (such as learning or decision-making) can moderate this relationship. Due to the high volume of information and data in today's business world, new information technologies help organizations, primarily institutionally owned companies, to store and process information effectively and make better decisions (AI-Hashimy et al., 2022). If accounting information systems cannot provide fast and timely information, these companies will not be successful in today's competitive and risky environment. To face these challenges, companies should benefit from various capital techniques to provide timely and economic financial information and improve their information systems and intellectual capital (Hutahayan, 2020). Business intelligence is how large organizations, such as institutionally owned companies, collect, analyze, and distribute information from internal and external sources to make better decisions. In this regard, different types of capital help companies provide high-quality and timely information for their strategic decisions, reduce risks, and create competitive advantages (Sumardjo and Supriadi, 2023). The support of senior managers and the simultaneous use of information systems and intellectual capital play an important role in the success of this process. As a result, this research investigates the effect of types of capital on the relationship between organizational culture and the

implementation of accounting information systems. The general result of the review of the few existing related backgrounds is that organizational culture can be an empowering platform for using the results of information technology, knowledge management, and information systems to improve organizational performance, intellectual capital, and job satisfaction. Meanwhile, organizational culture is a multi-dimensional and complex issue, and different levels can be seen in different organizations. These factors justify further studies in this field. Therefore, according to the above, this study examines whether organizational culture affects the information system and whether types of capital mediate the relationship between organizational culture and the information system.

2. Theoretical principles and hypothesis development

2.1 The relationship between organizational culture and the implementation of accounting information systems

Organizational culture is one of the critical success factors of projects that deal with organizational changes (Abadiyah et al., 2020). A strong organizational culture can play a primary role in creating motivation and cooperation among employees. A dynamic and robust culture shares the organization's fundamental values (Bhatti et al., 2020). Studies have shown that the atmosphere of relationships between employees and the existing issues governing the organization significantly impact the implementation of information systems. When the organization is involved with cultural problems, the employees' resistance causes the system to be abandoned entirely or implemented with reforms and without the support of much planning (Faeq and Ismael, 2022). A study shows that one of the reasons for many failures in implementing the organization's resource planning system is the need for more attention to the organizational culture. Today, many companies need to pay more attention to the organizational culture when implementing their resource planning system. Both in the implementation phase of the ERP system and its upgrade phase, paying attention to the organizational culture, especially risk-taking indicators, and involving users are vital and important variables (Bhatti et al., 2020). The studies that have dealt with the issue of culture and ERP systems can be divided into two categories; the first category is the studies that have investigated the national culture, and the other category is the studies that have dealt with the field of organizational culture. to (Ismanto et al., 2020). He pointed out that they will not be addressed because they are outside the focus area of this research.

Kordab et al. (2020) found that certain aspects of culture have evolved along with the technology of organizational culture, and the culture of organizational culture can explain why a system is adopted at a mediating level.

Lei et al. (2020) showed that people in urban areas emphasize using official information sources, while in rural communities, the emphasis is on verbal communication and informal information exchange. In addition, geographic dispersion, lack of awareness about information and information literacy, lack of alignment of information services with needs, financial and human barriers, and lack of appropriate information policy are among the most critical challenges related to the organizational culture of Maldives. Muafi et al. (2020) listed the characteristics of four types of organizational culture: result-oriented, rule-oriented, relationship-oriented, and risk-oriented. They believe that organizational culture is related to the organization's effectiveness. Nhon et al. (2020) showed a positive and significant relationship between the formal training of employees and the self-perceived level of project management characteristics. Pathiranage et al. (2020) found that the groups and individuals of these Dutch organizations work well together, and information systems management and organizational culture are related. The research results strongly correlate organizational culture variables and information systems management. Shahzad et al. (2023) found that managers prefer internal-personal information sources. In addition, the ranking of information sources is different

according to managers' union affiliation.

Yang et al. (2021) showed that organizational culture affects the general way of information management. Since investing in information systems is vital to facilitate absorbing and managing information, organizations should develop an information culture to develop electronic government and create, use, and manage information. Andrej et al. (2023) showed that between risky organizational culture and externalization of knowledge. There is a significant relationship between rule-based organizational culture and knowledge synthesis, result-oriented information culture and knowledge internalization, and relationship-oriented organizational culture and knowledge socialization. Saeidi et al. (2021) found that among the six dimensions of information culture based on Chu's framework, three of them, including integrity, professional activity, and informality, flow among the studied institutions. Meanwhile, there is a relationship between the dimension of organizational culture integration with job satisfaction, leadership style, and performance self-expression. Dana et al. (2021) found that organizational culture, as a valuable component of strategic information management, introduces a framework for developing information management strategies in business. They believe that the information culture of the organization's managers and employees significantly impacts solving information-related problems. Therefore, the first hypothesis is presented as follows:

H1: There is a significant relationship between organizational culture and implementing accounting information systems.

2.2. The relationship between organizational culture and the implementation of accounting information systems with the mediating role of types of capital

Types of capital affect the influence and power of companies. Companies with substantial human and intellectual capital have particular sensitivities due to the different nature of their activities, and the discussion of stakeholder theory is more prominent in them. In other words, in these companies, discussing the theory of stakeholders is more important than the theory of agency. Intellectual capital plays a vital role in the success of companies (Alawaqleh et al., 2021). Intellectual capital is a set of internal factors directly affecting the organization, especially listed companies (Anning-Dorson, 2021). Al-Omoush et al. (2022) showed that the management of intellectual resources, which is the title of the main field of management accounting studies, has emerged because intellectual capital and management accounting are mixed. In fact, according to the informational and managerial role of accounting, management has shown many reasons regarding the relationship between management accounting and various indicators of intellectual capital. It helps the primary value-creation process. The management accounting system designs a set of financial and non-financial management indicators to achieve the specific strategies and goals of the companies by combining the existing knowledge and new knowledge, as well as the available gaps for exploiting and using new knowledge. It is identified as increasing the social capital portfolio and improving intellectual capital indicators in high-risk and competitive conditions (Phornlaphatrachakorn and Kalasindhu, 2021). Al-Omoush et al. (2022) considered intellectual capital as a factor that is affected by anything and affects anything. Alassaf et al. (2020) showed that accounting information systems support the development of intellectual capital to improve its indicators (human capital, intellectual capital, and social capital. Ashok et al. (2021) showed a significant positive relationship between the company's intellectual, human, and intellectual capital indicators in improving accounting information systems. Baronian (2022) showed significant relationships between the stages of the social capital process and the indicators of accounting information systems.

Social capital involves acquiring, managing, and analyzing massive amounts of data about the company's stakeholders and existing relationships. Through social capital, companies can use the

information systems provided most effectively to obtain timely and quality information for decision-making, and by reducing existing risks and threats, competitive advantages are created (Lutfi et al., 2022). Social capital is closely related to management accounting systems as a data analysis source. Both play a role in improving the indicators of accounting information systems with their information perspective. The most important common point of human and spiritual capital and social capital is the subject of information and decision-making. The breadth and age of intellectual capital mean it can use accounting information systems to facilitate critical tasks and improve companies by modernizing the organizational culture and accounting information systems (Cadden et al., 2020).

Cui et al. (2022) considered intellectual capital a factor that is affected by anything and affects anything. Dahiyat et al. (2023) showed that organizational culture increases the expertise of management accountants due to the introduction of new and advanced decision-making techniques. On the other hand, it has a promoting effect on increasing management accounting techniques. Dhar et al. (2022) showed that business intelligence is related to the decision-making process based on environmental conditions in large companies.

Therefore, the second to fifth hypothesis is proposed as follows:

H2: Intellectual capital mediates the relationship between organizational culture and the implementation of accounting information systems.

H3: Social capital mediates the relationship between organizational culture and the implementation of accounting information systems.

H4: Human capital mediates the relationship between organizational culture and implementing accounting information systems.

H5: Intellectual capital mediates the relationship between organizational culture and the implementation of accounting information systems.

3. Research methodology

In the following, the collected data are analyzed through the questionnaire to examine the research model, discover the relationship between the variables, and test the research hypotheses. SPSS, Stata, and SmartPLS software will be used for data analysis, and hypotheses will be checked using various statistical methods.

4. Findings

4.1 Descriptive statistics

First, descriptive statistics of demographic questions are presented in Table (1). 191 participants completed the questionnaires. Most of the respondents were men, and most of them had master's degrees. Most people have an accounting position with 5 to 10 years of experience.

The designed questionnaire consists of 6 main sections, including organizational culture, intellectual capital, human capital, social capital, spiritual capital, and implementation of accounting information systems. The options before each question include completely agree, agree, neither agree nor disagree, disagree, and completely disagree, coded with numbers 1 to 5.

Table 1. Frequency of demographic data

	No.	Frequency		No.	Frequency
Gender			**Position**		
Female	30	15.71	Accounting	98	51.31
Male	161	84.29	Financial manager	76	39.79
Education			University professor	17	8.90
Less than a bachelor's degree	12	6.28	**Work experience**		
Bachelor's	76	39.79	Less than 5 years	30	15.71
Master's degree	93	48.69	5-10 years	90	47.12
Ph.D	10	5.24	11-20 years	40	20.94
			21-25 years	16	8.38
Total			Above 25 years	15	7.85

4.2. Inferential statistics

Cronbach's alpha coefficient, composite reliability coefficient, and average extracted variance were checked to check the validity and reliability of the research questionnaire. The alpha coefficient for the designed questionnaire is equal to 0.911, which is in the appropriate range. The average variance index was extracted to evaluate the structure's validity, and the Fornell and Larcker criteria were used. According to table (2), the AVE index for model variables is higher than 0.5; therefore, the convergence validity of the measured model is suitable. Also, to check the goodness of fit indices of measurement models, several methods were used; the summary of these tests and their acceptable ranges are summarized in Table (3). According to these results, it can be concluded that the model fit is suitable for the data, and the results obtained from it can be reliable.

Table 2. Reliability and validity findings of the research

Cronbach's Alpha	Composite reliability coefficient	AVE
0.911	0.862	0.751

Table 3. The goodness of fit criteria

Indicator	Sign	Calculation	Acceptable	Ideal
$\chi 2$ significance	χ^2	<0.002	$0.05 < p \leq 1.00$	$0.01 < p \leq .05$
Optimized chi-square	$\chi 2/df$	2.033	$0 < \chi^2/df \leq 5$	$0 \leq \chi^2/df \leq 3$
Good for him	GFI	0.897	$0.80 \leq GFI < 0.95$	$0.95 \leq GFI \leq 1.00$
Adjusted goodness	AGFI	0.875	$0.80 \leq GFI < 0.95$	$0.95 \leq GFI \leq 1.00$
Root mean square residual	RMR	0.052	$0 < RMR \leq 0.10$	$0 \leq RMR \leq 0.05$
Comparative fit index	CFI	0.903	$0.90 \leq CFI < 0.97$	$0.97 \leq CFI \leq 1.00$
The root mean square of the estimation error	RMSEA	0.048	$0.05 < RMSEA \leq 0.08$	$0 \leq RMSEA \leq 0.05$

The research variables were obtained by averaging the received answers to the questions in their sub-set, whose diagram will be drawn in Figure (1) below. In addition, in Table (4), the main components of the research, the number of questions, Cronbach's alpha, and factor analysis of each part of the questionnaire were also calculated. The questionnaire has a suitable internal structure because Cronbach's alpha is between 0.765 and 0.940. In the following table (5), the descriptive statistics of the variables were calculated.

Since the third option is neither agree nor disagree, a comparison of averages has been made by using a t-test and examining the average of less than three according to the arrangement of answers. According to the result of the t-test presented in Table (6), the null hypothesis of equality and greater than 3 for all the main variables of the research is rejected at the 99% confidence level. Therefore, as was said before, the people participating in the questionnaire significantly agreed with components such as organizational culture, intellectual, human, social, and spiritual capital and implementation. Accounting information systems have expressed.

Table 4. Components: number of questions, Cronbach's alpha and factor analysis results

Components	Questions	Cronbach's Alpha	Factor analysis
Organizational culture	16	0.908	0.877-0.971
Intellectual capital	16	0.891	0.879-0.991
Human capital	16	0.926	0.772-0.954
Social capital	17	0.911	0.874-0.972
Spiritual capital	13	0.936	0.762-0.974
1. Religiosity	4	0.940	0.883-0.928
2. Creativity	4	0.913	0.879-0.979
3. Ethics	3	0.938	0.772-0.974
4. Health	2	0.889	0.835-0.917
Implementation of accounting information systems	10	0.765	0.672-0.971

Table 5. Descriptive statistics of hidden research variables

Variables	Latin	Observations	Mean	Std. Dev.	Min.	Max.
Organizational culture	CUO	191	1.919	0.445	1.000	3.188
Intellectual capital	CAI	191	1.986	0.443	1.000	3.188
Human capital	CAH	191	1.972	0.506	1.000	3.250
Social capital	CAS	191	1.969	0.337	1.235	2.853
Spiritual capital	CAP	191	1.821	0.372	1.000	2.625
1. Religiosity	CAPR	191	1.787	0.487	1.000	3.000
2. Creativity	CAPC	191	1.791	0.449	1.000	2.750
3. Ethics	CAPE	191	1.888	0.428	1.000	3.000
4. Health	CAPH	191	1.819	0.497	1.000	3.000
Implementation of accounting information systems	AIR	191	1.863	0.412	1.100	4.200

Table 6. Comparison of averages

Variables	Latin	Observations	Mean	Difference	t statistic	Prob
Organizational culture	CUO	191	1.919	–1.081	–33.562	0.000
Intellectual capital	CAI	191	1.986	–1.014	–31.646	0.000
Human capital	CAH	191	1.972	–1.028	–28.075	0.000
Social capital	CAS	191	1.969	–1.031	–42.317	0.000
Spiritual capital	CAP	191	1.821	–1.179	–43.805	0.000
1. Religiosity	CAPR	191	1.787	–1.213	–34.459	0.000
2. Creativity	CAPC	191	1.791	–1.209	–37.193	0.000
3. Ethics	CAPE	191	1.888	–1.112	–35.937	0.000
4. Health	CAPH	191	1.819	–1.181	–32.800	0.000
Implementation of accounting information systems	AIR	191	1.863	–1.137	–38.161	0.000

After that, in Table (7), the Pearson correlation coefficient between the hidden components of the research was obtained. The correlation coefficient of the organizational culture variable with the information systems implementation variable (AIR) equals 0.458 at the 99% confidence level. The components of intellectual capital reinforce each other and have a direct and meaningful effect on each other. In the meantime, the effect of these components on spiritual capital (CAP) is such that the most significant effect belongs to creativity (CAPC), ethics (CAPE), health (CAPH), and religiosity (CAPR) with coefficients. The correlation is 0.845, 0.828, 0.792 and 0.740. Capital indices also reinforce each other. The correlation between the four capital indicators is positive and significant at 99% confidence. Among these variables, the highest correlation with the information systems implementation variable (AIR) belongs to human capital (CAH), social capital (CAS), spiritual capital (CAP), and intellectual capital (CAI), with correlation coefficients of 0.533. They have 0.526, 0.474, and 0.388.

Table 7. Correlation matrix of hidden research variables

Cuo	Cai	Cah	Cas	Cap	Capr	Capc	Cape	Caph	Air	
1										Cuo
0.594	1									Cai
0.595	0.577	1								Cah
0.475	0.384	0.628	1							Cas
0.589	0.713	0.615	0.472	1						Cap
0.273	0.625	0.445	0.369	0.740	1					Capr
0.657	0.619	0.654	0.442	0.845	0.502	1				Capc
0.470	0.509	0.445	0.443	0.828	0.446	0.681	1			Cape
0.496	0.526	0.430	0.272	0.792	0.397	0.548	0.565	1		Caph
0.458	0.388	0.533	0.526	0.474	0.500	0.434	0.323	0.260	1	Air

Note: All calculated coefficients are significant at the 99% level.

In Figure (1), the output and the effect of the hidden and apparent variables of the questionnaire according to the previous results to evaluate the views of managers and accountants on the influence of organizational culture as well as the mediating role of intellectual, human, social and spiritual capitals on the implementation of systems Accounting information has been drawn in Iraq. This figure shows that organizational culture positively and significantly affects the implementation of accounting information systems. Similarly, intellectual, human, social, and spiritual capital also positively and significantly affect the implementation of accounting information systems.

In the following, covariance analysis is used when there is more than one independent variable in the Mancova method. To use this method, the normality of the distribution of the variables was checked using the Kolmogorov-Smirnov test. Table (8) shows the results of this test. The null hypothesis of this test is that the variables have a normal distribution. According to the presented results, all the variables have a normal distribution.

Table 8. Normality test of variables

Variables	p-value	Variables	p-value
CUO	0.823	CAP	0.663
CAI	0.798	CHT	0.702
CAH	0.350	AIR	0.909
CAS	0.270		

Another critical assumption of covariance analysis is the homogeneity of regression coefficients. The interaction of the pre-tests with each group's hypotheses was insignificant, indicating the homogeneity of the regression coefficients. As can be seen, the non-significance indicates compliance with the assumption of the regression slope in Table (9), so the assumption F of the homogeneity of the regression coefficients is also established. Considering the establishment of covariance analysis assumptions, this statistical test is allowed.

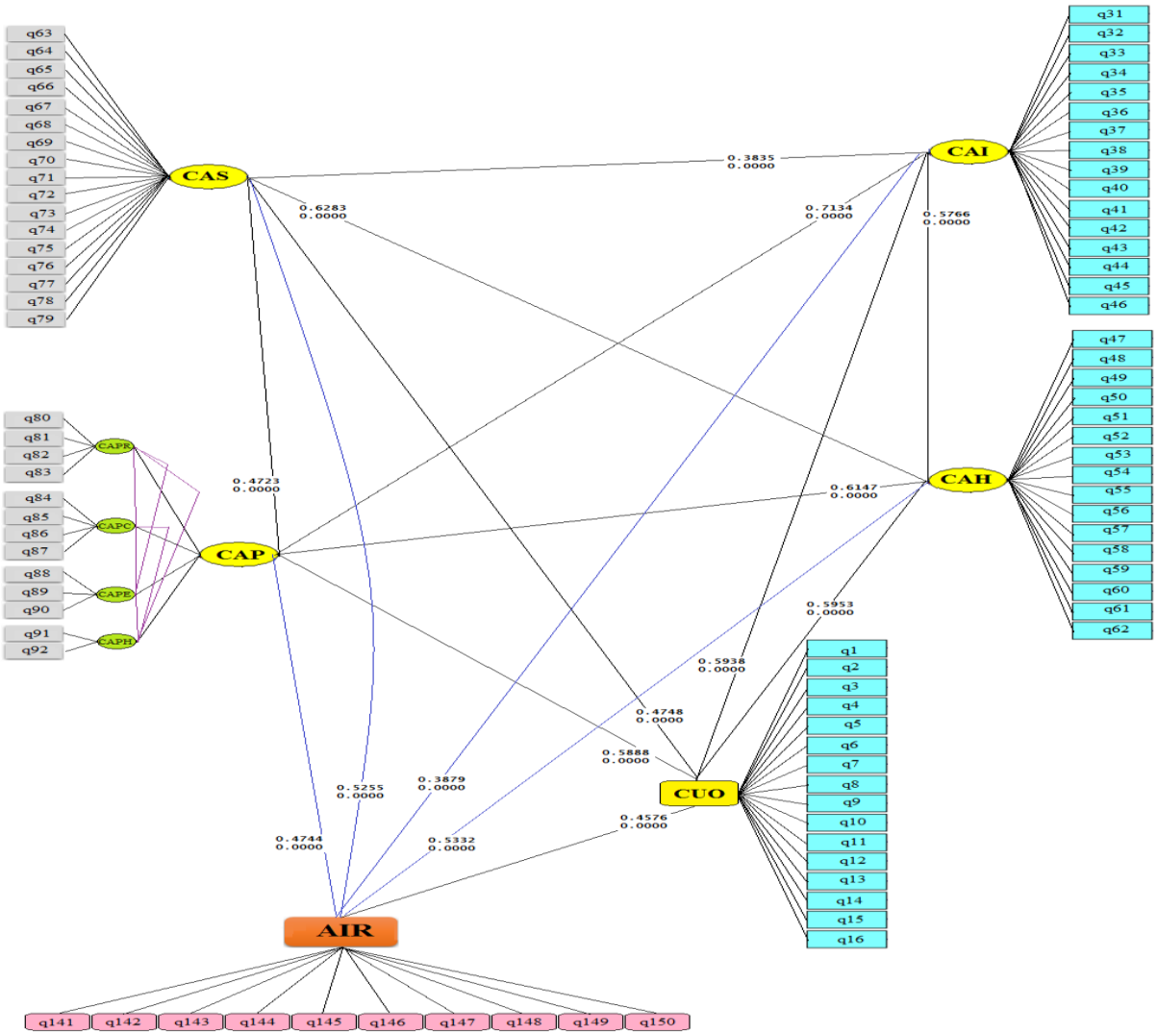

Figure 1. The output and the effect of the hidden and apparent variables

Table 9. Results of regression slope homogeneity test

Statement	Total squares	Mean squares	Degree of freedom	Statistic	Significance
The effect of organizational culture on the implementation of accounting information systems	8.971	8.971	1	0.763	0.623
The effect of intellectual capital on the implementation of accounting information systems	2.170	2.170	1	0.550	0.415
The effect of social capital on the implementation of accounting information systems	10.223	10.223	1	0.621	0.783
The effect of human capital on the implementation of accounting information systems	0.170	0.170	1	0.920	0.352
The effect of intellectual capital on the implementation of accounting information systems	1.400	1.400	1	0.680	0.409

Table (10) results indicate that the necessary conditions for using covariance analysis are met. The results of the one-way covariance test are presented in Table (11). The results of the variance analysis show that the significant value is greater than 0.05, so the research hypothesis cannot be rejected.

Table 10. One-way covariance test results

	Source	Total squares	Mean squares	F statistic	df	Significance	OTA
The effect of organizational culture on the implementation of accounting information systems	Pre-test*error group	8.971	8.971	1	0.763	0.623	0.120
The effect of intellectual capital on the implementation of accounting information systems	Pre-test*error group	2.170	2.170	1	0.550	0.415	0.150
The effect of social capital on the implementation of accounting information systems	Pre-test*error group	10.223	10.223	1	0.621	0..783	0.130
The effect of human capital on the implementation of accounting information systems	Pre-test*error group	0.170	0.170	1	0.920	0.352	0.080
The effect of intellectual capital on the implementation of accounting information systems	Pre-test*error group	1.400	1.400	1	0.680	0.409	0.030

The correlation test results in Table (11) show that the F value at the 99% level is significant for most research hypotheses, including the effect of social, intellectual, and human capital on the implementation of accounting information systems. In addition, the effect of intellectual capital on the implementation of accounting information systems has been accepted at the 95% confidence level.

Table 11. The results of the intergroup effects test

	Total squares	Mean squares	F statistic	Degree of freedom	Significance
The effect of organizational culture on the implementation of accounting information systems	3.689	3.689	2.169	1	0.004
The effect of intellectual capital on the implementation of accounting information systems	11.225	11.225	12.460	1	0.000
The effect of social capital on the implementation of accounting information systems	100.635	100.635	143.322	1	0.000
The effect of human capital on the implementation of accounting information systems	6.752	6.752	9.400	1	0.000
The effect of intellectual capital on the implementation of accounting information systems	4.580	4.580	4.580	1	0.047

After that, the ordinary least squares (OLS) method was used to investigate the effect of hidden variables on implementing information systems more closely. Table (12) shows the effect results, including coefficient and significance level. As it is known, hidden variables, including organizational culture and intellectual, social, human, and spiritual capital, affect the implementation of accounting information systems at the 99% confidence level. Structural equations were used to investigate the interactive effects of these variables following the research hypotheses and consider the demographic variables.

Table 12. The direction of the effect of hidden variables on the implementation of information systems

Conclusion	P-value	Coefficient	Effect direction
Organizational culture affects the implementation of accounting information systems.	0.000	0.423	AIR ← CUO
Intellectual capital affects the implementation of accounting information systems.	0.000	0.361	AIR ← CAI
Social capital affects the implementation of accounting information systems.	0.000	0.612	AIR ← CAS
Human capital affects the implementation of accounting information systems.	0.000	0.434	AIR ← CAH
Intellectual capital influences the implementation of accounting information systems.	0.000	0.525	AIR ← CAP
Intellectual capital mediates the relationship between organizational culture and the implementation of accounting information systems.	0.000	0.124	~~AIR~~ (CAI*CUO)
Social capital mediates the relationship between organizational culture and the implementation of accounting information systems.	0.000	0.177	~~AIR~~ (CAS*CUO)
Human capital mediates the relationship between organizational culture and the implementation of accounting information systems.	0.000	0.141	~~AIR~~ (CAH*CUO)
Intellectual capital mediates the relationship between organizational culture and the implementation of accounting information systems.	0.000	0.152	~~AIR~~ (CAP*CUO)

After that, the structural equation method is used to check the research hypotheses more precisely. Table (13) presents the fitting results separately for intellectual, social, human, and spiritual capitals. In the first model (Model 1), the Cuo variable coefficient at the 99% confidence level equals 0.937. Therefore, organizational culture becomes the factor in improving the implementation of accounting information systems, and the first hypothesis is accepted at the 99% confidence level. In addition, intellectual capital also becomes a factor in improving the implementation of accounting information systems at the 99% confidence level. The coefficient of this variable was equal to 0.668. The interactive variable Cai* Cuo coefficient is also positive and significant. Therefore, the second hypothesis that intellectual capital mediates the relationship between organizational culture and implementing accounting information systems is also confirmed at the 99% confidence level.

In the second model, the coefficient of the Cas variable was obtained at the 99% confidence level, equal to 0.683. Therefore, social capital is also a factor in improving the implementation of accounting information systems. The interactive variable Cas* Cuo coefficient was estimated to be positive but insignificant. Therefore, the third hypothesis is not confirmed. After that, the Cah variable coefficient was obtained at the 99% confidence level equal to 0.537. Therefore, human capital is also a factor in improving the implementation of accounting information systems. Also, the interactive variable Cah*Cuo coefficient is positive and significant. Therefore, the fourth hypothesis, that human capital mediates the relationship between organizational culture and implementing accounting information systems, is also confirmed at the 99% confidence level.

Table 13. Fitting structural equation regressions

	Model 1		Model 2		Model 3		Model 4	
Variable	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**
Cuo	0.937	0.000	0.412	0.001	0.400	0.063	0.573	0.014
Cai	0.668	0.000						
Cai* Cuo	0.312	0.004						
Cas			0.683	0.000				
Cas* Cuo			0.090	0.139				
Cah					0.537	0.006		
Cah* Cuo					0.114	0.000		
Cap							0.738	0.002
Cap* Cuo							0.185	0.038
Gender	0.021	0.787	0.074	0.317	0.073	0.333	0.069	0.379
Education	-0.007	0.874	0.010	0.800	-0.010	0.805	0.052	0.253
Position	-0.052	0.156	-0.061	0.085	-0.051	0.141	-0.083	0.024
Experience	0.022	0.417	0.035	0.163	0.030	0.249	0.022	0.410
Constant	-0.006	0.988		0.479	0.459	0.262	-0.023	0.961

In the fourth model, the coefficient of spiritual capital was fitted at the 99% confidence level equal to 0.738. Therefore, intellectual capital is also a factor in improving the implementation of accounting information systems. The interactive variable Cap* Cuo coefficient is also positive and significant. Therefore, the fifth hypothesis, that intellectual capital mediates the relationship between organizational culture and implementing accounting information systems, is also confirmed at the 95% confidence level. In general, according to the applied regressions, it can be concluded that among the components of capital, spiritual capital and social capital have the greatest effect, and human capital and intellectual capital have the least effect on implementing accounting information systems in Iraq.

In the following, quantile regression has been used to evaluate the coefficients obtained in different percentages of the variable implementation of accounting information systems. In table (14), the coefficient of organizational culture in lower values of AIR is small and becomes more intense with the increase in the implementation of accounting information systems. On the contrary, intellectual capital has a larger coefficient in smaller amounts of accounting information systems implementation. With the increase of the AIR variable, these coefficients become smaller and smaller. Hence, considering that the intensity of the two variables of organizational culture and intellectual capital increase in the opposite direction, the interactive variable Cai* Cuo has the most effect in the middle quartiles and the first quartile at the level of 95% and in the fourth quartile, it is not significant on the AIR variable.

In the second model, the influence coefficient of the social capital variable decreases in the last quartile. The interactive variable Cai* Cuo is also significant and positive in the first two quartiles at 99%. In the last two quartiles, unlike the estimate of the structural equation system. Therefore, social capital mediates the relationship between organizational culture and implementing accounting information systems below the average. The influence coefficient of the human capital variable also increases with the increase in the implementation of accounting information systems.

Nevertheless, human capital mediates the relationship between organizational culture and the implementation of accounting information systems in smaller amounts of accounting information systems implementation. The influence coefficient of intellectual capital also increases in the last quadrants of implementing accounting information systems. Nevertheless, intellectual capital in the last quadrant, unlike the first three quadrants, does not mediate the relationship between organizational culture and the implementation of accounting information systems.

Table 14. The fit of quantile regressions

Variable		25%		50%		75%		100%	
		Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Model 1	Cuo	0.610	0.017	0.670	0.000	0.802	0.000	0.913	0.039
	Cai	0.836	0.000	0.924	0.000	0.638	0.000	0.116	0.575
	Cai* Cuo	0.287	0.029	0.225	0.000	0.347	0.000	0.046	0.720
Model 2	Cuo	0.700	0.000	0.892	0.004	1.045	0.000	1.031	0.000
	Cas	1.213	0.000	1.665	0.000	1.064	0.253	0.801	0.268
	Cas* Cuo	0.400	0.002	0.634	0.005	0.362	0.415	0.592	0.095
Model 3	Cuo	0.323	0.000	0.511	0.000	0.959	0.000	0.749	0.429
	Cah	0.238	0.000	0.759	0.000	1.053	0.000	0.862	0.268
	Cah* Cuo	0.308	0.001	0.435	0.000	0.230	0.000	0.300	0.073
Model 4	Cuo	0.871	0.000	0.706	0.000	1.194	0.001	0.925	0.001
	Cap	0.706	0.000	1.021	0.000	1.473	0.000	1.147	0.044
	Cap* Cuo	0.383	0.000	0.423	0.000	0.579	0.001	0.047	0.673

After that, the impact of sub-indices of spiritual capital, including religiosity, creativity, ethics, and health, on implementing accounting information systems and their mediating role in the relationship between organizational culture and AIR variables were investigated. In Table (15), religiosity and ethics increase the implementation of accounting information systems at the 90% confidence level. Still, they do not affect the relationship between organizational culture and the AIR variable. On the contrary, creativity at 99% confidence and health at 95% confidence are factors in improving the implementation of accounting information systems in Iraq. These variables affect the relationship between organizational culture and AIR variable at the 95% confidence level, and their mediating role is confirmed.

Table 15. Investigating the mediating role of intellectual capital components

	Model 1		Model 2		Model 3		Model 4	
Variable	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Cuo	0.635	0.000	0.805	0.021	0.849	0.031	0.979	0.018
Capr	0.681	0.070						
Capr* Cuo	0.166	0.231						
Capc			0.743	0.010				
Capc* Cuo			0.284	0.015				
Cape					0.631	0.061		
Cape* Cuo					0.258	0.148		
Caph							0.623	0.033
Caph* Cuo							0.319	0.048

5. Discussions and conclusion

Organizational culture includes shared values, norms, and behaviors that are formed in the organization and determine how employees interact with technological changes and innovations (Danish et al., 2021). Organizations with open and innovative cultures are usually more receptive to new technologies encountered, and this makes the accounting information systems to be implemented in a better way. By strengthening cooperation and coordination among organizational members, organizational culture provides the basis for accepting information systems and using them to improve decisions and internal control. In addition to examining the relationship between organizational culture and accounting information systems, this research also examines the role of

capital types in this relationship. For example, intellectual capital, which includes the organization's knowledge, skills, and experiences, can improve the productivity of accounting information systems. Also, social capital can facilitate the successful implementation of systems by strengthening relationships between organization members and creating cooperation networks. Human capital, which includes the development of employees' skills and their empowerment, plays an important role in the adoption and optimal use of these systems. Finally, intellectual capital can also help to better implement accounting information systems by influencing the values and beliefs of employees to strengthen organizational commitment. This type of capital helps to strengthen the sense of belonging and gives meaning to the work in the organization. It can lead to the improvement of interactions between members and increase the effective use of information systems. As a result, investigating the mediating effects of types of capital in the relationship between organizational culture and the implementation of accounting information systems can provide effective solutions to improve organizational performance. The analysis of these relationships shows that organizational culture alone cannot guarantee the success of implementing accounting information systems. However, the mediating role of types of capital is significant. Organizational culture can affect the effective use of existing funds and improve the process of implementing information systems through the synergy of these funds. Therefore, to achieve optimal results, organizations should not only focus on strengthening their organizational culture but also develop their human, social, and structural capital and use them in a coordinated way to implement accounting information systems. The following are the results of the research:

The research results showed a significant relationship between organizational culture and the implementation of accounting information systems. Therefore, organizational culture can influence how information systems are accepted and used in the organization and improve the performance of these systems. When the organizational culture is positive and especially emphasizes innovation, continuous learning, and support for technology, accounting information systems are implemented better. In such environments, employees are more willing to accept technological changes and can more easily adapt to new technologies. This leads to increasing the effectiveness of information systems and improving accounting processes. On the other hand, a negative organizational culture or resistance to change can hinder the successful implementation of accounting information systems. For example, cultures that emphasize strict hierarchies or fear of mistakes and failure may increase employee resistance to technological change and reduce the effectiveness of information systems. Therefore, this result points to the importance of creating and strengthening an appropriate organizational culture to improve the implementation of information systems in the organization. The results of the research are consistent with the results of Pathiranage et al. (2020), who found that groups and individuals in Dutch organizations work well together, that information systems management and organizational culture are related to each other, and the results of Yang et al. (2021) showed that organizational culture affects the general method of information management. Dana et al. (2021) also found that the information culture of managers and employees of the organization greatly impacts solving problems related to information, which is in line with the results of the present study.

The results also show that intellectual, human, and spiritual capital mediates the relationship between organizational culture and the implementation of accounting information systems. In organizations with well-developed intellectual capital, employees have the necessary knowledge and skills to use information technologies. With a better understanding of the benefits and capabilities of accounting information systems, these people can play a key role in adopting and implementing these systems. On the other hand, an open and supportive organizational culture, which emphasizes knowledge sharing and innovation, can contribute to forming strong intellectual capital. In such

organizations, specialized knowledge and professional experiences are constantly shared between individuals and teams, which leads to increased efficiency of information systems. By influencing employees' ability to understand and work with complex technologies, human capital can reduce implementation barriers and allow organizations to use accounting information systems more effectively. In other words, a strong relationship between human capital and organizational culture makes employees more prepared for technology-related changes, facilitating information systems' implementation. With its emphasis on ethical values, intellectual capital can promote transparency, honesty, and trust in information systems, promoting their effective and optimal use. The research results are consistent with the results of Alassaf et al. (2020), who showed that accounting information systems support the development of intellectual capital to improve its indicators (human capital, spiritual capital, and social capital). Also, the results of Ashok et al. (2021) showed a significant positive relationship between the company's investment amount in the indicators of intellectual, human, and spiritual capital in improving accounting information systems. The results of Baronian (2022), who showed significant relationships between the stages of the social capital process and the indicators of accounting information systems, align with the results of the present study.

The results also indicated that social capital does not affect the relationship between organizational culture and the implementation of information systems. In some Iranian organizations, social capital may need to be fully developed or limited to informal relationships and small groups. These limitations can make social capital unable to effectively mediate the implementation of accounting information systems. Especially in work environments where formal and hierarchical relationships prevail, social capital may not act as a facilitating factor in technological change.

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IJAAF; Vol. 9, No. 2, Spring 2025, Serial 31

Iranian Journal of
Accounting, Auditing & Finance

Ferdowsi University of Mashhad

Quarterly

RESEARCH ARTICLE

A Qualitative Model of the Firm's Sustainability Reporting(SR) Requirements in the Iranian Capital Market, Inspired by the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) Standards

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How to cite this article:
Zhaleh Azadzanjani, M. , Fazeli, N. and Faghani Makrani, K. (2025). A Qualitative Model of the Firm's Sustainability Reporting(SR) Requirements in the Iranian Capital Market, Inspired by the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) Standards. Iranian Journal of Accounting, Auditing and Finance, 9(2), 93-111. doi: 10.22067/ijaaf.2025.44716.1424
https://ijaaf.um.ac.ir/article_44716.html

ARTICLE INFO

Article History
Received: 2024-02-14
Accepted: 2024-11-08
Published online: 2025-04-15

Keywords:
Capital Market, Reporting, Sustainability Reporting(SR), GRI Reporting Standard, SASB Reporting Standard

Abstract

The paper primarily aims to provide a qualitative model of the company's sustainability reporting requirements in the Iranian capital market, inspired by the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) standards. The study population can be divided into three general groups for quantitative data analysis: (1) industry experts, (2) public stakeholders, and (3) academic experts. Finally, after the distribution of 200 instruments, the sample size equals 180 research experts, sampling methods (judgmental) and snowball sampling. The data collected is related to the period between the winter of 2022 and the spring of 2023. The research data analysis method is "content analysis" in the MAXQDA environment. One of the main findings of the research is that the qualitative model of SR in Iran's capital market includes the main variables such as management of the company's legal and regulatory environment in terms of leadership and governance requirements in SR; Health and safety of human capital in human capital requirements of SR; stakeholders' performance Disclosure of the most crucial company performance criteria in the stakeholders' performance of the management's interpretive report; The flexibility of the business model based on costs in the economic requirements of the business model and innovation in SR; customer welfare was presented based on the promotion of education and training in the social capital requirements of SR and the management of energy and fuel consumption in the environmental requirements of SR. The current research is innovative in various aspects. First, the recent research is considered innovative in terms of subject matter. According to the compilation of international GRI standards of 2018, the SASB of 2019, the conceptual framework of integrated reporting of 2016 at the international level and the interpretive reports of the management of companies admitted to the Tehran Stock Exchange in 2016, and the obligation of publishers to disclose the details of energy consumption approved since November 2021 efforts to examine the relationship between the financial and non-financial aspects of the sustainability of each type of this reporting thoroughly seem necessary. Also, this paper tries to address all the critical criteria of economic, environmental, and social performance (KPI) of the SR of the world and Iran. Finally, presenting the SR model of companies takes the first step in providing professional sustainability reports in Iran.

https://doi.org/10.22067/ijaaf.2025.44716.1424

CC BY

NUMBER OF REFERENCES
32

NUMBER OF FIGURES
3

NUMBER OF TABLES
9

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

Traditional financial accounting procedures do not measure and reveal all the elements that cause success, and the elements that affect the company's progress should be addressed. Therefore, stakeholders - for example, institutional investors, insurance companies, individual shareholders, and non-governmental organizations demand more non-financial information from companies, and these demands will make companies more and more motivated to prepare and publish environmental and social reports (Bellandi, 2017).

Meanwhile, developments in companies worldwide, especially in terms of sustainable development, show the importance of companies integrating sustainability aspects into their corporate reporting process. The accountability aspect of the companies is not complete without considering the dimensions of sustainability; therefore, publishing and disclosing the requirements of sustainability reports in the economic, environmental, and social sectors in the annual reports of the companies or as a separate report provides valuable information for a wide range of stakeholders. The content of sustainability reports or in the form of independent reports, including the management interpretive report and the disclosure of material and energy consumption information of the companies listed in the Tehran Stock Exchange or the annual reports of those companies, has attracted the attention of the Iranian capital market in recent years. These reports are published as mandatory or voluntary disclosure of hidden information in the financial statements and reports of the board of directors to the shareholders' assembly. This type of reporting has fundamental flaws and needs regular and consistent compliance with several common SR standards used worldwide, including the international GRI standards and the SASB (Sustainability Accounting Standards Board) standards. Also, preparing environmental, social, and governance reports and sharing this information with high security and effectively and immutably in the form of a coherent information platform for making strategic decisions at the macro-economic level requires uniform, comprehensive requirements at the national level by the custodians of Iran's capital market should be compiled and made mandatory (Zhaleh Azad Zanjani, 2018b).

First, the present research examines the reports of the companies admitted to the stock exchange, including financial statements, the report of the board of directors to the assembly and the management's interpretive report, and the disclosure report of the amount of energy consumption of the companies admitted to the Tehran stock exchange.

Then, by using a sample group composed of the main groups of industries whose names are in the list of companies admitted to the stock exchange, we want to examine the status of SR of these companies and its effects in providing helpful information for the stakeholders, to investigate quantitatively and qualitatively. To what extent do the companies of the main groups listed in the companies admitted to the stock exchange adhere to the requirements of SR in the world, and whether it is possible to prepare an optimal, local, and beneficial model for the Iranian capital market under the standards of GRI and SASB.

In this sense, the information of all the publishers accepted in the Tehran Stock Exchange in the groups of food industries (10 companies), medicine (14 companies), automobiles (26 companies), and petrochemicals (25 companies) for the year 2021 in terms of the level of adherence of companies to sustainable structures companies and the degree of compliance of financial and non-financial reports of these companies with the standards of GRI and international integrated reporting and SASB

examined.

This research can contribute to developing the literature in this field by presenting a comprehensive and complete model of corporate SR. It can provide a broad perspective of SR based on different but integrated dimensions of the company's information environment.

2. Theoretical review and background

2.1 Corporate sustainability

Corporate Sustainability is an approach to creating long-term value for the company's stakeholders through an environmentally friendly business strategy. In this approach, efforts are made to focus on economic, cultural, social, environmental, and ethical dimensions. Also, long-term goals should be preserved to achieve short-term goals (Hajiha and Chenari, 2023). Corporate sustainability is an economic and pragmatic approach that can create opportunities and risks for trade and commerce. The subject of corporate sustainability is a broad, complex, and evolving concept that includes diverse attitudes and ideas. In the beginning, this concept was related to the financial perspective of companies. Also, its primary goal was to maximize shareholder value so that companies benefit through long-term sustainability (Aljajawy et al., 2022). The nine principles of sustainability and corporate responsibility are (Nwobu, 2017; Asogwa, 2023 and Parfitt, 2022), The nine principles of sustainability and corporate responsibility presented in Table 1:

Table 1. The nine principles of sustainability and corporate responsibility (source: Nwobu, 2017; Asogwa, 2023 and Parfitt, 2022)

Professional ethics of the company	Ethical companies establish and promote fair and honest standards and practices for all the company's stakeholders and encourage the adoption of such an approach among other stakeholders (including business partners, distributors, and suppliers).
Business relations	Companies should establish mutual relations with their suppliers by treating them as valuable and long-term partners, inviting the cooperation and participation of their talented forces, receiving their ideas and opinions, and attracting the loyalty of these partners.
Participation in local communities	Companies that value partnerships with local communities and economic development partner with community activists and companies that seek to strengthen health, education, safety, and economic development standards.
Transparency of financial information	Through open and fair communication, transparent companies fully disclose information about the company's past, present and, if possible, future performance to current and potential investors and lenders.
Financial returns for investors	The company compensates the capital provided by investors and lenders by providing a competitive rate of return on investment and protecting its assets. The interests of investors and lenders should be identified, and the company should establish formal mechanisms to facilitate ongoing dialogue with its investors.
Company management system	This principle reflects the commitment to effective and conscientious management of all resources and recognizes the fiduciary responsibility of the board of directors and company managers to focus on the interests of all stakeholders.
Value of products and services	Adherence to this principle prompts companies to respect the needs, hopes and rights of investors and end consumers, to offer high-quality products and services, and to be committed to customer satisfaction, truth, and safety.
Environmental Protection	The company is always trying to continuously improve the efficiency of using all types of energy, reducing the consumption of water and other natural resources, and reducing the release of hazardous substances into the air, water and soil. Also, adheres to its commitment to maximizing the production and use of recycled and recyclable materials, increasing the durability of its products, and minimizing packaging.
The company's recruitment practices	Companies that admit to this principle know that paying attention to human capital and investing in it benefits human capital, society, and the company itself in the long run. For this purpose, they offer programs such as salary compensation and benefits, family time during the day, and career development opportunities.

Successful companies in the field of sustainability usually have clear strategies that direct the company's sustainability activities, and the relationship between sustainability and the company's strategy in these companies is usually clearly described. In addition, these companies' sustainability activities and goals are usually aligned, and integrating them shapes their corporate structure and management processes. In these companies, sustainability is not a secondary element but a part of how the company functions (Kücükgül et al., 2022).

2.2 Corporate sustainability reporting

From another point of view, Sustainability Reporting (SR) is the company's economic, social, and environmental performance, which shows how a business unit will implement its development plans in the future, considering these issues. For this reason, corporate SR policies are considered an essential part of corporate strategies. In this way, large companies usually accept their sustainability reports as an organizational strategy (UNGC, 2015).

The contemporary world faces numerous environmental and social challenges whose proper administration and management depend on the attention and commitment of industries to SR (Fathi, 2023). In other words, the structures, laws, and regulations of SR in government and industry are mandatory pressures for SR. However, the lack of government supervision on reporting and the industry managers' inattention to it reduces the role of these pressures. Professional and scientific institutions create normative pressure for SR in this industry. However, the inattention of auditing companies to this reporting moderates this pressure (Mir Zamani et al., 2019). Today, sustainable development is one of the most essential concerns of industries and companies, and the survival of companies in the competitive market implies having corporate sustainability strategies.

Despite numerous frameworks and standards, it is difficult for most companies to find sustainability criteria in each specialized area and report on it. SR discloses environmental, social, and governance issues. However, in the service industry, guidelines have yet to be prepared regarding SR, and no service company has designed SR (Rahmani et al., 2022). The benefits of SR are present in Table 2 (Alawattage et al., 2023; Rosati and Faria, 2019 and Palea, 2018):

Table 2. Benefits of SR (source: Alawattage et al., 2023; Rosati and Faria, 2019 and Palea, 2018)

Identification of risks and better understanding of opportunities and challenges	One of the benefits of SR is that it helps to have an overall and comparative view of the company. If a company benefits from real data and analysis regarding its conditions, would it not be easier to plan?
Clarifying the company's strategy and goals	A company can document its long-term strategies and goals in SR and plan for them accurately; clarifying this information allows companies to review and improve.
Increasing motivation and loyalty of human capital	Today's human capital examines its employers with much higher standards than in the past decades, and the culture that governs a company is of great importance for human capital. SR creates more trust and loyalty in human capital by showing the company's achievements in human capital.
Improving brand reputation and welcoming investors	It is no secret that investors are also looking for companies responsible for society in today's market. Therefore, by compiling and publishing SR, it can be ensured that what the company advocates will also reach the ears of consumers.

The World Organization Council for Sustainable Development (2002) defines sustainability reports as public reports by companies to provide a picture of the company's economic, environmental, and social activities to internal and external stakeholders. According to the content of GRI (2018), the company will be measured for its performance towards achieving the sustainable development goal, its activities will be disclosed, and it will be accountable to the stakeholders. SR is a report about the company's daily activities' economic, environmental, and social impacts. SR is the expression of a company's performance. It impacts the three main sides of the triangle of

sustainable development, i.e., society, economy, and environment. It is directly related to the concept of social responsibility of business enterprises (Asogwa, 2023). A company undertakes corporate social responsibility so that, in addition to trying to achieve its own goals, it is aware of the effects and consequences of its activities on its stakeholders and tries to improve these effects and consequences. Sustainability reports go far beyond what is tangibly visible from a company's achievements. Titles such as the social responsibility and non-financial results reports are also synonymous with SR. Many companies publish such a report annually (Michalak et al., 2023).

2.3 Sustainability reporting requirements

One of the ways to express and measure the activities and effects of a company in various economic, social, and environmental fields is SR. In today's world, most international companies publish an annual report of their activities and environmental impact. The first step in developing SR is choosing the proper framework. For any company, data management and reporting issues are inevitable (Del Mar Alonso-Almeida et al., 2014). The SR framework helps the company achieve its goals for measuring and improving its environmental and social impacts by specifying priorities. As companies worldwide increasingly embrace SR, standards, and frameworks, it has emerged that companies can use them to measure and express their achievements (Aljajawy et al., 2022; Cho et al., 2022).

The Fifth Industrial Revolution incorporates concepts such as sustainability, big data, etc., and sustainability is among the main goals of countries and companies. However, Iran has paid less attention to this issue. In other words, there are currently causal, intervening, and context conditions, and the strategies and consequences of this type of reporting have not been investigated. The research results of Abdi et al. (2019) show that the main Causal conditions that lead to sustainability reporting are environmental requirements, environmental incentives, environmental pressures, the country's cultural and social characteristics, the country's political and the international environment's characteristics. Research findings also show that to achieve SR; strategies should be developed such as identifying the entity responsible for sustainability, formulating principles and sustainability standards, establishing a sustainability and social responsibility committee in companies, familiarizing and training sustainability, establishing an internal control and effective reporting system and use new technologies.

2.3.1 Interpretive report of management in Iran

The interpretive management report is a suitable solution to increase the disclosure of relevant information in the market (Taherinia and Darbandi Farahani, 2022). The accountability of companies to social, economic, and environmental stakeholders is a vital issue that has been studied from different approaches. Management interpretive report including requirements for disclosure of the nature of the business in the interpretive report; Requirements for disclosure of management goals and management strategies to achieve those goals in the interpretive report; Disclosure requirements of the most important sources, risks, and relationships in the interpretive report; The requirements for disclosing the results of operations and perspectives in the interpretive report and the requirements for disclosing the most critical performance criteria for performance evaluation in comparison with the goals in the interpretive report (Zhaleh-Azad Zanjani, 2019b).

2.3.2 Global Reporting Initiative (GRI)

The Global Reporting Initiative (GRI) aims to empower decision-makers everywhere to take action for a more sustainable economy and world through SR standards and its multi-stakeholder network. More than 100 countries consult GRI on corporate impact on critical sustainability issues.

The GRI SR standard reveals each company's positive and negative impacts on the environment, society, and economy. GRI standards are designed to apply to all types of companies worldwide. Instead of focusing on how external factors affect companies, the GRI standard focuses on how a company's actions affect society. A practical framework that reports to investors and a more comprehensive range of stakeholders. The Global Sustainability Standards Board publishes the GRI standards in the following four sections: Public Sector Standards (GRI 100), economic sector standards (GRI 200), environmental sector standards (GRI 300), and social sector standards (GRI 400) present in Table 3 (Zhaleh-Azad Zanjani, 2018a and Zhaleh-Azad Zanjani, 2018b):

Table 3. Summary of key performance measures under each subject standard, along with year of publication

Key criteria	Code	Standard type	Key criteria	Code	Standard type	Key criteria	Code	Standard type
Economic performance	1-201	Economic	Raw material	1-301	Environmental	Employment	1-401	Social
Presence in the market	1-202	Economic	Energy	1-302	Environmental	Employee and employer relations	1-402	Social
Indirect economic effects	1-203	Economic	water and sewage	1-303	Environmental	Occupational safety and health	1-403	Social
Purchase procedure	1-204	Economic	biological diversity	1-304	Environmental	Education and training	1-404	Social
anti-corruption	1-205	Economic	Gas emissions	1-305	Environmental	Diversity and equal opportunities	1-405	Social
Anti-competitive behavior	1-206	Economic	wastage	1-306	Environmental	Nondiscrimination	1-406	Social
Tax	1-207	Economic	Compliance with biological laws and regulations	1-307	Environmental	Freedom of association and collective bargaining	1-407	Social
	-		Bio-evaluation of suppliers	1-308	Environmental	Working Children	1-408	Social

2.3.3 American Sustainability Accounting Standards Board (SASB)

With an emphasis on social and environmental actions, SSE has integrated its standards into the particular form of supplementary corporate information Q10 and K10, which must be provided by companies admitted to the United States Securities and Exchange Commission. In this sense, it is different from initiatives like GRI by working in the current system of financial regulations and providing an independent report. To eliminate the need for industry-specific reporting standards, for the ease of comparison and the standard of doing this work, SASB has designed a sustainable industry classification system and an independent theoretical framework that includes ten sectors and 80 industries. The dimensions of sustainability used in the development of American SR standards are as follows in Figure 1 (SASB, 2023):

2.4 The concept of capital market

"Financial markets" are among the most influential markets in the economies of "countries with large economies." The recession and boom of the stock market affect the national and world economies. Therefore, there is a significant relationship between stock market developments and economic stagnation and prosperity, and in turn, macro policies in any country primarily affect the

macroeconomic variables and especially the monetary variables of the stock market of that country; interactions between markets have been discussed and investigated by financial experts for a long time. have been. Forecasting the stock market is very complicated because there is no proper and specific rule for estimating or predicting the stock price in the stock market (Bazari Jagargh, 2022). On the other hand, considering the current conditions of the country and the intensification of sanctions, the need to strengthen the domestic economy is felt even more. In other words, the stock market is the financial infrastructure of commercial, industrial, government, and private activities, and economists refer to it as the engine of economic development that provides long-term financial resources. In such a way, creating markets such as the stock exchange, over-the-counter market, and commodity exchanges creates the context for the optimal allocation of funds to plans, projects, and capital assets (documents of the Stock Exchange website, 2023).

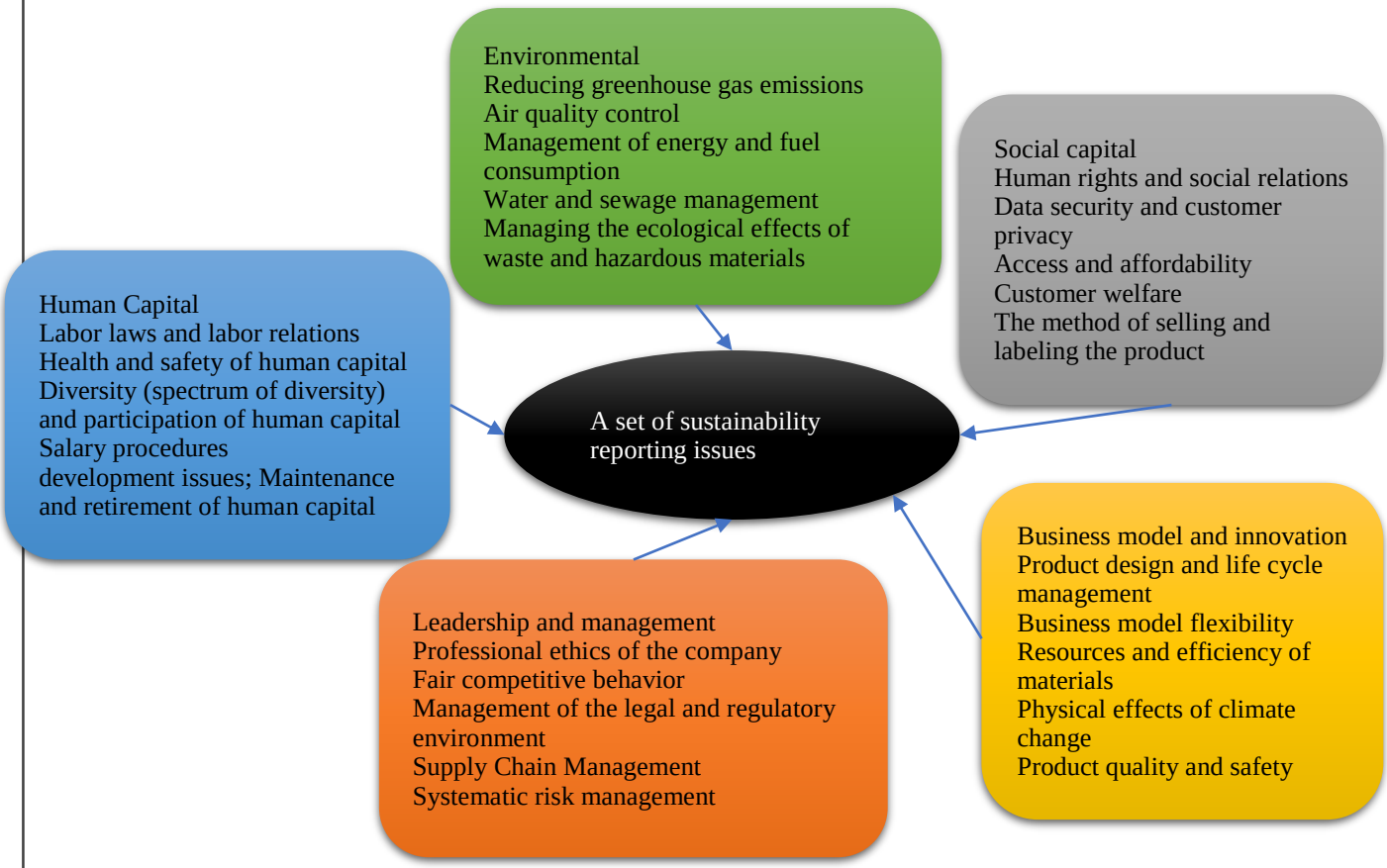

Figure 1. Dimensions of sustainability used in the development of American sustainability reporting standards (source: SASB, 2023)

2.5 Research background

In the following, based on the standard arrangement based on the year of publication, the most relevant studies in the internal background of research until 2023 and the external background of research until 2023 are presented in Table 4:

2.6 Research model

Finally, after examining and reviewing the theoretical foundations and background of the research, it was determined that due to the existence of research gaps in the field of identification, Prioritization, and modeling of business model requirements and innovation in SR, leadership and management requirements in SR, stakeholder performance of management interpretive report, environmental requirements of SR, social capital requirements of SR, human capital requirements of SR, in Tehran Stock Exchange; and also due to the lack of a model to provide recommendations to the manager to decide on the qualitative model of SR in the Iranian capital market, it is possible to realize the innovation of conducting the present research in solving the research above gaps. The primary framework of the research specifies the relationship between the variables and the manner of this relationship for the qualitative model of SR in the Iranian capital market presented in Table 5:

Table 4. Summary of existing studies in domestic and foreign background

The domestic background of the research	The international background of the research
Fathi's research (2023) investigates the most important economic consequences of audit quality by considering the quality of financial reporting.	In Erlandsson et al.'s (2023) research, the SR framework of ICT companies was created based on planetary boundaries.
The purpose of Hajiha and Chenari's research (2023) is to investigate the impact of the comparability of financial statements on the quality of financial reporting with an emphasis on audit quality.	In Asogwa's research (2023), the evaluation of SR acceptance criteria by non-governmental organizations (NGOs) based on the agenda for sustainability policies was discussed.
Rahmani et al.'s research (2022) investigated SR standards in the global insurance industry, their comparative comparison, and the status of publishing SR by insurance companies worldwide.	In the research of Alawattage et al. (2023), the political discourse model of sustainability accounting was designed based on moral economy and executive materialism.
The research of Nakhai et al. (2022) was conducted to investigate the relationship between SR, social responsibility reporting (CSR) and environmental reporting.	In the research of Al-Shaer and Hussainey (2022), SR beyond the business case and its impact on sustainability performance were investigated based on evidence from British companies.
Taherinia and Darbandi Farahani's (2022) research investigated the bilateral relationship between the simultaneous disclosure of the interpretive report and management profit forecast on information symmetry and investment quality with the role of adjusting the representation of environmental uncertainty in companies listed on the Tehran Stock Exchange.	A 2021 review examines the environmental consequences of economic recovery after COVID-19 by Chu et al.
The research of Esmailzadeh et al. (2021) aimed to identify, extract, refine, prioritize and analyze social factors and corporate characteristics that effectively impact the SR of pharmaceutical companies in Iran.	According to Narula et al. (2021), the application of Industry 4.0 technologies was evaluated in the adoption of the Global Reporting Initiative (GRI) standards to achieve sustainability.
Taghavi Godarzi and Fazilat's research (2021), while explaining the challenges of public sector accountants in reporting sustainability and environmental changes, presented some new theoretical foundations in this field.	In the research of Papoutsi and Sodhi (2020), a model was presented to investigate the role of financial disclosure in sustainability reports on the actual performance of sustainability.
Mir Zamani et al.'s (2019) research attempted to identify the factors that influence SR in Iran's oil industry by using the qualitative content analysis method and relying on institutional theory.	In the research of Rosati and Faria (2019), sustainable development goals were investigated in sustainability reports based on the theory of the company's institutional factors.

According to the investigations carried out in the Scopus, ScienceDirect, Springer, Iran Doc,

Islamic World reference database, and also the studies in the top universities of the country, this method is presented as a guideline to provide a qualitative model of the reporting requirements of the company's sustainability in the Iranian capital market with inspiration, from the standards of the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) using the MAXQDA qualitative analysis environment. It can help the Tehran Stock Exchange as a new and efficient way to improve managers' decision-making, Iran's capital market, accounting professors and students, auditing, financial management, and economic development.

Table 5. Research model variables

Variable title	Variable measurement metrics	Reference
Environmental requirements for SR	Reducing greenhouse gas emissions Air quality control Management of energy and fuel consumption Water and sewage management Managing the ecological effects of waste and hazardous materials	Erlandsson et al. (2023); Asogwa (2023); Al-Shaer and Hussainey (2022); Narula et al. (2021); Rosati and Faria (2019); Alawattage, et al. (2023); GRI (2023); SASB (2023); CDSB (2023)
Social capital requirements of SR	Human rights and social relations Data security and customer privacy Access and affordability Customer welfare The method of selling and labeling the product	Alawattage, et al. (2023); Rosati and Faria (2019); Al-Shaer and Hussainey (2022); GRI (2022); SASB (2023); IIRC(2023)
Human capital requirements of SR	Labor laws and labor relations Health and safety of human capital Diversity (spectrum of diversity) and participation of human capital Salary procedures development issues; Maintenance and retirement of human capital	Erlandsson et al. (2023); Papoutsi and Sodhi (2020); Palea (2018); Asogwa (2023); GRI (2023); SASB (2023); IIRC (2023); IFRS (2023)
Business model requirements and innovation in SR	Product design and life cycle management Business model flexibility Resources and efficiency of materials Physical effects of climate change Product quality and safety	Narula et al. (2021); Nwobu (2017); Del Mar Alonso-Almeida et al. (2014) ; Al-Shaer and Hussainey (2022) ; GRI (2023); SASB (2023); IIRC (2023); VRF (2023**)**
Leadership requirements in SR	Professional ethics of the company Fair competitive behavior Management of the legal and regulatory environment Supply Chain Management Systematic risk management	Aljajawy, et al. (2022); Papoutsi and Sodhi (2020); Cho et al. (2022); Rydell and Kristoffersson (2017); GRI, (2023); SASB (2023); IIRC (2023)

Stakeholder performance management interpretive report	Beneficiaries disclosure of the nature of the business Stakeholders Disclosure of management goals and management strategies to achieve those goals Stakeholders disclosure of the most important resources, risks and relationships Stakeholders' disclosure of results of operations and prospects Stakeholders Disclosure of the most important performance measures to evaluate performance against objectives	Tehran Stock Exchange and Management's Interpretive Report Rules)

3. Research Methodology

The research method in this article is a qualitative type of content analysis to provide a qualitative model of the company's SR requirements in the Iranian capital market, inspired by the standards of the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB). The library method will collect the data required for this research. This way, the theoretical foundations of the research and background will be extracted by referring to books, articles, and other available sources. To use the library method in examining the requirements of Iran's management interpretive reports with common SR standards in the world, we perform the following steps:

Checking keywords and research terms

Collecting articles and studies related to the topic of fake news

Memorizing information related to the research problem and research variables

Analysis of information related to the mentioned variables

In other words, the studied population of this research can be divided into three general groups in the quantitative part: the first group includes professors who have an opinion on the field under investigation; The second group includes professionals working in the Tehran Stock Exchange, and the third group comprises professional investors and independent researchers (public stakeholders). This research's sampling method combines non-probability targeted (judgmental) and snowball sampling. The case study in this research is the capital market of Iran.

In the continuation of the research, action is taken after considering the strategic nature of the qualitative SR model in the Iranian capital market, analyzing the aforementioned factors, and using the MAXQDA qualitative analysis environment. The data analysis tool used in previous research for the qualitative SR model in the Iranian capital market is MAXQDA software, which analyzes qualitative data obtained from expert interviews (determining research variables and criteria). Analysis of research data based on the qualitative method of content analysis to identify and extract the main dimensions, components, and metrics of SR in the stock market industry and the identification of stakeholders with the importance of the stock market industry will be done because content analysis is a qualitative research method to identify, analyze and interpret the semantic patterns of qualitative data. According to the research objectives, content analysis may have different standards or flexibility, but usually, the stages of content analysis research projects include the following steps (Mazidi and Dastori, 2021):

- Preparing data
- Description of the unit of analysis
- Development of classes and coding scheme
- Drawing the results of coded data

- Report of methods and findings.

4. Data analysis

The stages of data analysis based on the qualitative method of content analysis, using Maxqda software to analyze the qualitative data obtained from the interviews with experts (determining research variables and criteria) are:

4.1 Data preparation

In this research, the statistical population of the qualitative section includes companies admitted to the Tehran Stock Exchange in four industry groups: food industry (10 companies), medicine (14 companies), automobile (26 companies), and petrochemicals (25 companies), which are among the major groups. The industries of the companies listed in the Tehran Stock Exchange are in the time domain of March 29, 2021. The community of the qualitative part of this research, which measures the readiness of companies for SR in Iran using the theoretical ghost method, includes 15 experts from the Tehran Stock Exchange. In the following, the relative frequency of compliance with the SR requirements of Iran's capital market is presented based on the data measuring companies' readiness for SR in Iran present in Table 6:

Table 6. The relative frequency of compliance with sustainability reporting requirements based on the data measuring companies' readiness for sustainability reporting in Iran

Readiness measurement criteria	Pharmaceutical Industry			Car Industry			Food Industry			Petrochemical Industry		
	N.N.C*	N.C**	S.N***	N.N.C*	N.C**	S.N***	N.N.C*	N.C**	S.N***	N.N.C*	N.C**	S.N***
Economic GRI 200	49	189	238	85	357	442	16	154	170	186	239	425
Environmental GRI 300	274	174	448	566	266	832	170	150	320	508	292	800
Social GRI 400	65	467	532	286	702	988	108	272	380	441	509	950
Total	402	844	1232	948	2848	3796	308	1152	1460	1160	2490	3650
Relative frequency of non-compliance	33%			25%			21%			32%		
Relative frequency of compliance	67%			75%			79%			68%		

* No. of non-compliance(N.N.C) ** No. of compliance (N.C) *** Sample no.(S.N)

Based on the analysis of the relative frequency of compliance with the SR requirements of the Tehran Stock Exchange, it was determined that food and automobile companies with a compliance ratio of 79 and 75% have a better situation than pharmaceutical and petrochemical companies with a compliance ratio of 67 and 68%. In fact, in the three sectors of GRI, i.e., economic sector - environmental sector - social sector, out of a sample of 3796 in automotive companies, 2848 cases comply with SR requirements (economic sector 81% - environmental sector 32% - social sector 71%) and In a sample of 1460 food companies, 1152 cases of compliance with SR requirements were reported (economic sector 91% - environmental sector 47% - social sector 72%). While, out of a

sample of 1232 in pharmaceutical companies, 844 cases of compliance with SR requirements (economic sector 79% - environmental sector 39% - social sector 88%) and out of a sample of 3650 in petrochemical companies, 2490 cases of compliance with SR requirements (Economic sector 56% - environmental sector 37% - social sector 54%) is reported. Listed companies in the food, automotive, pharmaceutical, and petrochemical sectors pay little attention to the environmental sector of SR because the compliance ratio is less than 50%, while the highest compliance ratio is in the environmental sector.

4.2 Description of the unit of analysis

The unit of analysis in the content analysis of this research is specifically related to the meaning and production of content. It conveys the qualitative model of SR in the Iranian capital market. To determine and finalize the criteria by implementing the qualitative part of the research, the opinions of 15 financial and investment experts working in the Tehran Stock Exchange, Iran's capital market, as well as academic experts in accounting fields, auditing; financial management and economic development; Financial and investment experts who are experts in the field of research were gathered in the form of structured interviews between the winter of 2022 and the spring of 2023. The demographics of the qualitative part of the research show that the experts have the "experience (relevant work experience) and knowledge (relevant educational qualification)" necessary to participate in the research. In the stage of word selection for the analysis unit in the content analysis of this research, the main concepts of the qualitative model of SR in Iran's capital market have been extracted from the implementation of qualitative methodology in the study in the form of variables and criteria emphasized by experts. Here are some of the outputs of the structured interviews with the experts presented in Table 7:

Table 7. Extraction of concepts based on research analysis unit

Leadership and governance requirements in SR	Environmental requirements for SR
Stakeholder performance management interpretive report	Social capital requirements of SR
Economic imperatives of business model and innovation in SR	Human capital requirements of SR

The extraction of concepts based on the research analysis unit shows that the environmental requirements of SR, social capital requirements of SR, leadership and governance requirements in SR, economic requirements of business model and innovation in SR; the human capital requirements of SR and the performance of the stakeholders of the management interpretive report are the main concepts of the qualitative model of SR in the Iranian capital market.

4.3 Development of classes and coding scheme

To develop the categories and coding scheme in this research, six categories were extracted, which are: environmental requirements of SR; social capital requirements of SR; leadership and governance requirements in SR; economic requirements of business model and innovation in SR; human capital requirements of SR and stakeholder performance interpretive reporting of management. In the following, we will provide details about the sub-components of an example of the development of classes and the coding plan action was taken present in Table 8:

Table 8. Sub-components of the environmental requirements dimension of SR

Sub-components of the environmental requirements dimension of sustainability reporting	**Repetition in reports**	**Frequency in exchanges**	**Content analysis**	**Interview**

Management of energy and fuel consumption	56	16	√	√
Environmental awareness for air quality control	44	14	√	√
Reducing greenhouse gas emissions	39	12	√	√
Water and sewage management	11	5	√	√
Managing the ecological effects of waste and hazardous materials	7	3	√	√

After analyzing the interviews related to the environmental requirements of SR, it was found that "management of energy and fuel consumption; environmental awareness to control air quality and reduce greenhouse gas emissions" has a higher frequency than "water and wastewater management and management of the ecological effects of waste materials and are dangerous" in the stability reports of stock exchanges and experts' opinions. Finally, after refining the raw data, the interview structure established a relationship between the main concepts and their sub-components. Here, the distribution of the experts' responses in the segmentation of the research content shows that for each of the six main variables in the qualitative model of SR in the Iranian capital market, three criteria have been extracted:

• The "Leadership and Governance Requirements in SR " component includes criteria such as the board of directors' policy for fair, competitive behavior; management of the legal and regulatory environment of the company; and systematic risk management.

• The "stakeholder performance of the management interpretive report" component includes stakeholder performance, disclosure of the most critical company performance criteria, stakeholder performance disclosure of operating results and prospects, and stakeholder performance disclosure of the essential resources, risks, and relationships.

• The "environmental requirements of sustainability reporting" component includes criteria such as reducing greenhouse gas emission energy and fuel consumption and environmental awareness for air quality control.

• The "social capital requirements of SR " component includes criteria such as human rights and social relations, data security, and customer privacy. The welfare of customers is based on the promotion of education.

• The "Economic requirements of business model and innovation in SR " component includes criteria such as quality and safety of various products and services, flexibility of the cost-based business model, Resource management, and economic efficiency of materials.

• The "human capital requirements of SR " component includes criteria such as labor laws and labor relations, health and safety of human capital, and appropriate payroll procedures for human capital.

Finally, to report methods and findings, the ranking of research codes based on their repetition in the coding matrix is as follows in Table 9:

Code	All coded segments	Position
AB	12	2
BA	11	4
EB	11	14
FB	11	17
DC	10	12
EA	10	13
CB	9	8
FC	9	18
AC	8	3
BC	8	6
CA	8	7
CC	8	9
DA	8	10
FA	7	16
EC	6	15
AA	5	1
BB	5	5
DB	5	11

Figure 2. Criteria resulting from the qualitative analysis of the variables of the qualitative model of sustainability reporting

Table 9. Ranking of research codes based on frequency

Components	Concept	Code	No. of code frequency Source	Frequency percentage
Management and governance requirements in SR with code (A)	A- The policy of the board of directors regarding fair, competitive behavior	AA	5	%43
	B- Managing the company's legal and regulatory environment	AB	12	%80
	C- Systematic risk management of the company	AC	8	%53
Stakeholders' Performance Management Interpretive Report Coded (B)	A- Stakeholders' performance Disclosure of the most important performance criteria of the company	BA	11	%73
	B- Stakeholders' performance in disclosing the results of operations and prospects	BB	5	%43
	C- The performance of the beneficiaries of the disclosure of the most important resources, risks and relationships	BC	8	%53
Environmental requirements for SR with code (C)	1- Reduction of greenhouse gas emissions	CA	8	%53
	2- Management of energy and fuel consumption	CB	9	%60
	3- Awareness of the environmental sector to control air quality	CC	8	%53
Social capital requirements for SR with code (D)	A- Human rights and social relations	DA	8	%53
	B-data security and customer privacy	DB	5	%43

	C- The welfare of customers based on the promotion of education	DC	10	%67
Economic requirements of business model and innovation in sustainability reporting with code (E)	1- Quality and safety of various products and services	EA	10	%67
	2-Flexibility of the business model based on costs	EB	11	%73
	3- Management of resources and economic efficiency of materials	EC	6	%40
Human capital requirements for SR with code (F)	A- Labor laws and labor relations	FA	7	%47
	B- Health and safety of human capital	FB	11	%73
	C- Appropriate salary procedures for human capital	FC	9	%60

According to Figure 2, the most repeated criteria resulting from the qualitative analysis of the variables of the qualitative model of SR in the Iranian capital market are:

• Management of the legal and regulatory environment of the company with code (AB) has the most repetition in management and governance requirements in SR with code (A) with a frequency of 12 out of 15 experts.

• Health and safety of human capital with code (FB) has the most repetition in human capital requirements of SR with code (F) with a frequency of 11 out of 15 experts.

• Beneficiaries' performance Disclosure of the most critical performance criteria of the company with the code (BA) having the most repetition in the performance of the stakeholders of the management interpretive report with the code (B) with a frequency of 11 out of 15 experts.

• Cost-based business model flexibility with code (EB) has the most repetition in business model economic requirements and innovation in SR with code (E) with a frequency of 11 out of 15 experts.

• Customer welfare based on the promotion of education and training with the code (DC) has the most repetition in the social capital requirements of SR with the code (D) with a frequency of 10 out of 15 experts.

• Management of energy and fuel consumption with the code (CB) has the most repetition in the environmental requirements of SR with the code (C) with a frequency of 9 out of 15 experts.

According to the above calculations, the qualitative model of SR in Iran's capital market is presented as follows:

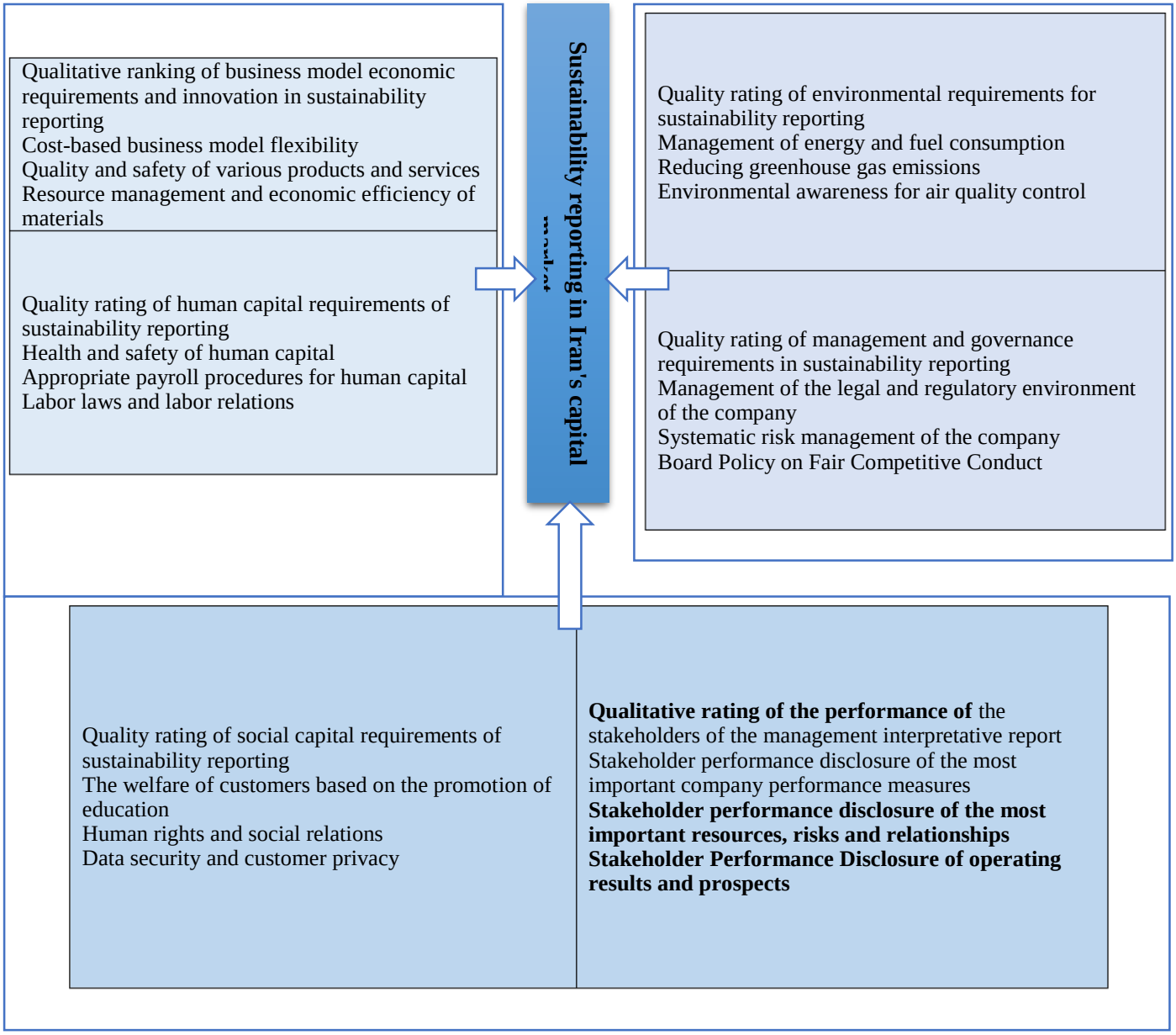

Figure 3. Qualitative model of SR in Iran's capital market

According to Figure 3, to check to what extent the measurement tool of this research measures the desired characteristic, scientific documents and corporate standards as well as some experts working in the Tehran Stock Exchange have been used and the variables of the initial decision-making model after applying their opinions using qualitative methodology, reached its final form. The research's conclusion was presented after finalizing the research model's variables and criteria.

5. Conclusion and practical implications

5.1 Conclusion

The primary purpose of this research is to examine the requirements of the reports published in the Tehran Stock Exchange with the common SR standards in the world to provide an optimal SR model

for the Iranian capital market. The study population of this research can be divided into three general groups for quantitative data analysis: the first group includes experts and professionals working in the Tehran Stock Exchange (industry experts), the second group includes professional investors and independent researchers (public stakeholders) and the third group includes professors—expert in accounting, auditing, financial management, and economic development (academic experts), categorized. Finally, after the distribution of 200 instruments, the sample size of this research is equal to 180 research experts who are available and willing to cooperate with a combination of two non-probability targeted sampling methods (judgmental) and snowball sampling. The data related to the localization tool of the research variables were collected between the winter of 2022 and the spring of 2023. This thesis's research method combines qualitative analysis methods in MAXQDA, Statistical analysis in SPSS, and multi-criteria decision-making in expert choice. In this regard, the most important result obtained from this research is that the qualitative model of SR in Iran's capital market includes the main variables such as: management and governance requirements in SR (the policy of the board of directors regarding fair competitive behavior; management of the legal and regulatory environment company; systematic risk management of the company); stakeholder performance of management interpretive report (stakeholder performance disclosure of the most essential company performance measures; Stakeholder performance disclosure of operation results and prospects; Stakeholder performance disclosure of the most critical resources, risks and relationships); environmental requirements for SR (reduction of greenhouse gas emissions; management of energy and fuel consumption; environmental awareness for air quality control); Social capital requirements of SR (human rights and social relations; data security and customer privacy; customer welfare based on the promotion of education and training); economic requirements of the business model and innovation in SR (quality and safety of diverse products and services; flexibility of the business model based on costs; resource management and economic efficiency of materials); human capital requirements are SR (labor laws and labor relations; health and safety of human capital; appropriate salary and wage procedures for human capital).

5.2 Practical implications

From another point of view, based on the findings related to the environmental requirements of SR, i.e., reducing greenhouse gas emissions, management of energy and fuel consumption, Environmental awareness to control air quality, research proposals based on green supply chain management of products are:

• Paying attention to green production: In product manufacturing, there are several stages for green production, which include initial research and development, obtaining permission from the supervisory authority to sell the product in the market, and the final phase of commercialization.

• Sustainable distribution of the product to the point of supply: This stage includes the transportation and management of the production of goods from the producer to the final consumer, which can be a retail supplier or a customer. The complexity of this path varies according to the producer's location, the need to import, special requirements, and the location of the final consumer between the centers of big cities and remote villages.

• Supply to the final consumer: customization and providing the suitable form and size of products and services for customers according to a precise schedule is the final step in the value chain.

Based on the results of this research, the research suggestions based on the sustainability of the profitability of listed companies are attention to mandatory pricing in the industry, resiliency in dollar rate fluctuations, and reducing the effects of economic sanctions.

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IJAAF; Vol. 9, No. 2, Spring 2025, Serial 31

Iranian Journal of
Accounting, Auditing & Finance

Ferdowsi University of Mashhad

Quarterly

RESEARCH ARTICLE

Modeling the Relationship between Financial Stability and Banking Risks: Artificial Intelligence Approach

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How to cite this article:
Faraj Gumar, H. , Piri, P. and Heydari, M. (2025). Modeling the Relationship between Financial Stability and Banking Risks: Artificial Intelligence Approach. Iranian Journal of Accounting, Auditing and Finance, 9(2), 113-133. doi: 10.22067/ijaaf.2025.45952.1498
https://ijaaf.um.ac.ir/article_45952.html

ARTICLE INFO

Article History
Received: 2024-07-09
Accepted: 202-12-16
Published online: 2025-04-15

Keywords:
Financial Stability Efficiency, Machine Learning, Neural Network

Abstract

This aims to evaluate the effect of financial stability efficiency on the financial stability of banks in Iran and Iraq. In addition, this study aims to identify the main factors affecting financial stability and provide solutions to improve risk management and banking supervision. The statistical population of this research includes 66 banks (22 Iranian banks and 44 Iraqi banks) listed on the stock exchanges of Iran and Iraq. The study period is from 2000 to 2023. A wide range of artificial neural network approaches and machine learning algorithms have been used for data analysis. These methods include artificial neural network, deep neural network, convolutional neural network, recurrent neural network, self-organizing neural network, gradient boosting, random forest, decision tree, spatial clustering, k-means algorithm, k-nearest neighbor, support vector regression and support vector machine. This diversity in analytical methods provides the possibility of comprehensive comparison and evaluation of factors affecting the financial stability of banks. The results of various analyzes show that machine learning models and neural networks have a significant performance in examining and evaluating the financial stability of banks. The artificial neural network showed the highest accuracy with a coefficient of determination of 0.95. Gradient boosting and random forest also had high performance with determination coefficients of 0.9566 and 0.9441. Spatial clustering and k-means algorithms could group banks based on their financial stability with an accuracy of nearly 100%. The variables of capital adequacy ratio, cash flow, bank size, and Z score were identified as the most important factors affecting financial stability. Deep, convolutional, and recurrent neural network models also showed similar performance with coefficients of determination of about 0.94. Support vector regression and support vector machine also provided acceptable results with determination coefficients of 0.9162 and 0.8500. This study emphasizes using artificial intelligence approaches in risk management and banking supervision. The research findings help develop early warning systems, improve banking supervision, and formulate more efficient monetary policies in Iran and Iraq. It is suggested that the monetary authorities of the two countries use these results to revise the capital adequacy rules and strengthen the banks' liquidity management.

https://doi.org/10.22067/ijaaf.2025.45952.1498

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49

NUMBER OF FIGURES
-

NUMBER OF TABLES
6

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

As a business depository and lending institution, the banking industry is vital in the national and global economy (Lobo, 2017). An efficient banking system is one of the prerequisites for the economic development of a country. Banks are the pulse of financial activities and their status can significantly impact other sectors of the economy. Banks facilitate trade and commerce by organizing and directing payments and receipts, leading to market expansion, growth and economic prosperity. In developing countries with underdeveloped financial markets, banks are usually the only institutions capable of financial intermediation and can help reduce investment risk by providing various methods (Amiri and Tawfighi, 2016). Therefore, the health and efficiency of the banking system have always been of interest because efficient and healthy banks can be effective in economic growth; their unhealthy and weak performance can also cause financial and economic crises (Rezaei, 2017). Sufficient and reliable capital is one of the necessary conditions for maintaining the health of the banking system, and each bank and credit institution must always establish a proper ratio between the capital and the risk of its assets to ensure the stability and health of its activities. The main function of this ratio is to protect the bank against all financial and non-financial risks, including unexpected losses and to protect depositors and creditors (Hugonnier and Morellec, 2017).

Efficiency is one of the most important performance indicators of economic units. Although there are several definitions, the common denominator is that an efficient firm gets the most output from a given combination of data (Chen et al., 2018). Today, banks play an essential role in development strategies, and even in economies with advanced financial markets, banks are at the centre of financial and economic activities. Banks are often the only institutions that can provide financial intermediation in developing and transition economies with less developed financial markets.

Financial stability is the ability of the financial system, financial institutions, markets and market infrastructures to withstand possible shocks and imbalances while reducing the probability of failure in the performance of financial intermediation functions. Financial stability is essential for further economic development. The global financial crisis of 2007-2008 demonstrated the interconnectedness of the financial system through the banking network, the possibility of rapid transmission of losses from one bank to other banks, and the spread of instability in this network. Thus, a stable monetary system includes the ability to allocate resources efficiently, assess and manage financial risks, maintain the level of employment close to the natural rate of the economy, and eliminate changes in the relative prices of financial and real assets that affect monetary stability and the level of employment. Instability in the financial system means the inability of banks to finance profitable projects and the imbalance in their financing performance. Therefore, major instability in the financial system may lead to banking turmoil, severe inflation, collapse of capital markets and weakening of international confidence in financial markets and economic systems (World Bank, 2016).

However, despite the critical importance of the banking sector, the increasing complexity of financial instruments and the globalization of financial markets have increased the risks banks face. There has been a surge in financial stability concerns in recent years, driven by market volatility, cyber threats, regulatory changes, and economic uncertainties. These challenges have increased the potential for systemic risk, making banks more vulnerable to crises that can have far-reaching consequences for national and global economies. The increasing frequency of financial disruptions underscores the need to examine the factors contributing to or mitigating these risks.

Against this background, it is important to examine why this research is warranted. Understanding the interplay between efficiency and financial stability is crucial, as improving operational efficiency can enhance profitability and strengthen a bank's resilience to financial shocks. Focusing on the increasing risks and the urgent need for stability in the banking sector, this study aims to provide

valuable insights that can inform strategies to safeguard financial systems. This research is particularly relevant in light of the recent global financial challenges, which highlight the importance of developing robust mechanisms to maintain stability and reduce the likelihood of future crises.

Based on the themes above, it can be concluded that the purpose of this research is to investigate the relationship between efficiency and financial stability and its impact on the financial sustainability of banks. In other words, this study analyses how operational efficiency and financial stability affect banks' ability to maintain financial resources and manage financial risks. It can also help to identify effective factors in improving banks' financial stability and assess financial institutions' role in this process.

The future structure of the article includes research literature (consisting of theoretical literature and research background), methodological research (including research method, statistical population and research model), research findings, conclusions and suggestions, and finally, sources and references. This structure is comprehensive and coherent to present the research.

2. Research literature

Keynes (1936) described the crisis of the financial system and the factors affecting it in general by referring to the fluctuations of a sensitive monetary system. In the late 2000s, Minestie's theory gained much attention due to the subprime mortgage crisis. He became famous by introducing the hypothesis of financial instability. Mishkin (1999) stated that the instability of financial conditions is caused by financial classification and the inability to raise capital for investment to invest in investment. Wen and Yu (2013) studied the developing concept of financial stability. A bank's performance and stability depend on its knowledge and technology. Therefore, it is essential to identify factors that create value and impact the economy, financial performance, and especially in the bank (Ella et al., 2023).

Many studies show that banks, to comply with minimum mandatory capital requirements, proceed to halt the granting of loans. One of the prominent theories in this area is the capital crunch theory, which predicts that the amount of lending during recession periods is sensitive to capital regulatory controls. In situations where mandatory capital decreases and leads to distress, external capital increases, and consequently, the amount of loans granted by banks also decreases (Acharya and Ryan, 2016).

With a paradigm shift towards financial liberalization resulting from financial repression in the 1980s and 1990s, banking sectors—initially in developed countries and later in developing countries—have experienced increasing levels of competition, bringing two opposing views regarding financial stability. The competition–stability view states that competition can positively affect financial institutions' stability (Schaeck and Čihák, 2014). From this perspective, Boyd and De Nicoló (2005) suggested that lower interest rates in a competitive market reduce borrowing costs and increase entrepreneurial successes, which helps stabilize banks and leads to reduced credit risk. In contrast, in a concentrated market with less competition, a few large banks can impose higher interest rates, which may increase the volume of non-performing loans and lead to bank bankruptcies.

Schaeck and Čihák (2014) examined 3,600 European and over 8,900 U.S. banks and demonstrated that competition, measured using the Boone indicator, benefits banking health. Schaeck et al. (2009) also explained that banks maintain buffer capital in a competitive environment, reducing the propensity toward financial crises. Similarly, Kasman and Carvallo (2014) consider competition favorable for financial stability. A recent article by Noman et al. (2018) analyzed the role of banking regulations on the relationship between competition and financial stability and showed that both competition and regulatory policies promote financial stability and reduce credit risk in the banking

system.

The competition–fragility concern implies that increasing competition in the financial services industry reduces financial institutions' market power and profitability. Financial institutions are likely to have a greater tendency to invest in high-risk portfolios to compensate for financial losses. As a result, this risky behavior can undermine the stability of financial institutions. Llewellyn believes that such competition can lead to the failure of these sectors. Additionally, according to Allen and Gale, in a competitive market, banks tend to make less effort to assess customers to grant more credit and earn higher profits, which can increase the risk of credit default and banks' vulnerability.

Based on the theoretical framework presented, the relationships between financial stability, banking risks, and the identified factors are deeply interconnected. Increased competition in the banking sector, stemming from financial liberalization, influences financial stability through two main channels. The competition stability view posits that heightened competition leads to lower interest rates, reducing borrowing costs for entrepreneurs, enhancing their success rates and stabilizing banks by lowering credit risk (Boyd and De Nicoló, 2005). Conversely, the competition fragility concern argues that increased competition diminishes banks' market power and profitability, prompting them to engage in riskier investment portfolios to compensate for reduced earnings. This risky behavior elevates banking risks and can undermine financial stability. Additionally, regulatory policies like mandatory capital requirements significantly impact lending behaviors. During recession periods, strict capital regulations may lead to a capital crunch, where banks halt loan provisions to comply with capital requirements, further aggravating economic downturns and affecting overall financial stability (Acharya and Ryan, 2016).

Moreover, lending practices such as procyclical lending play a crucial role in the interplay between banking risks and financial stability. Procyclical lending, characterized by excessive lending during economic booms and restricted lending during recessions, can amplify economic fluctuations and contribute to financial instability (Mishkin, 1999). Regulatory frameworks that inadequately account for loan loss reserves may inadvertently encourage such lending patterns, increasing banks' vulnerability during economic downturns. Efficiency factors, including banks' knowledge and technological capabilities, influence this dynamic by affecting banks' ability to manage risks and maintain stability (Ella et al., 2023). Efficient banks are better equipped to assess credit risk accurately, adjust to competitive pressures, and adhere to regulatory requirements without excessively curtailing lending activities. Therefore, the interrelationships among the competition, regulatory policies, lending behaviors, efficiency, banking risks, and financial stability are complex and multifaceted, with each factor exerting significant influence on the others as evidenced in the literature (Schaeck and Čihák, 2014; Noman et al., 2018). Therefore, numerous studies in this regard, which are reviewed in Table 1, examine empirical studies on financial stability efficiency and its effects on the financial sustainability of banks.

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which predicts that the amount of lending during recession periods is sensitive to capital regulatory controls. In situations where mandatory capital decreases and leads to distress, external capital increases, and consequently, the amount of loans granted by banks also decreases (Acharya and Ryan, 2016). The study by Anvari et al. (2018) indicates that banking sector credits can increase the stock market size index, and the cessation or freezing of loan granting may lead to market failure. Additionally, regulatory authorities believe that current rules for calculating loan loss reserves create procyclical effects in lending. Here, cyclical or procyclical lending means granting more loans during boom periods and not providing sufficient facilities during recessions.

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Given the reviews conducted in the theoretical foundations and existing literature in areas related to efficiency, financial stability, and their effects on the financial sustainability of banks, especially in Iraq and Iran, it becomes clear that sufficient serious studies have not been conducted in these areas. In particular, none of these studies have precisely examined the relationships between financial efficiency and financial stability on the financial sustainability of banks. This indicates that the present research in this area is unique and noteworthy. Moreover, the richness of the subject literature is very weak at both domestic and international levels.

As a result, this study attempts to examine financial efficiency, financial stability, and their effects on the financial sustainability of banks by utilizing scientific capacities and quantitative analysis methods and to tailor the obtained results to the banking systems of the countries under study. Thus, it can be claimed that this comprehensive and complete study not only serves as a scientific source for answering the main research questions but can also play an important role in its applicability and impact on financial and banking decision-making. Furthermore, by employing modern approaches such as neural networks and machine learning, this research can increase the depth of analysis and accuracy of predictions, contributing to advancing knowledge in this field.

Table 1. The empirical studies on financial stability efficiency and its effects on the financial sustainability of banks

Authors	Title of Study	Objective of Study	Key Findings
Berger and Bouwman (2013)	Bank Liquidity Creation, Monetary Policies, and Financial Crises	Examine the relationship between bank liquidity creation and financial stability	Banks with greater liquidity creation perform better in financial crises and have more financial stability.
Elbadry (2018)	Bank's financial stability and risk management	The study examines the effect of Saudi banks' financial stability indicators on their risk management practices.	The findings indicate that the capital adequacy ratio negatively impacts credit risk, while the leverage ratio positively affects it. Provisions, leverage, loans-to-deposits ratio, and bank size negatively affect liquidity risk. Additionally, capital adequacy, provisions, leverage, and asset utilization ratios positively influence operational risk, whereas the loan-to-deposits ratio has a negative effect on it. Overall, Saudi banks experienced significant improvement in financial stability from 2011 to 2014, enhancing their ability to manage risks.
Abdallah et al (2019)	Efficiency and Financial Stability of Commercial Banks in Kenya	Explore the relationship between efficiency and financial stability in Kenya	High efficiency in Kenyan banks leads to significant improvements in financial stability.
Safarzadeh et al(2019)	Designing and explaining the stability model of the banking system based on the quality of financial reporting	The study aims to model banking stability based on the quality of financial reporting and identify strategies to enhance stability through financial reporting quality.	The results confirm the hypotheses that strong financial reporting quality is directly related to banking stability, and utilizing a dynamic storage method rather than a static one can help stabilize the banking network by improving the quality of banks' financial reporting.
Onumah and Duho (2019)	Intellectual Capital: Its Impact on Financial Performance and Financial Stability of Ghanaian Banks	The study investigates the effect of intellectual capital (IC), measured by the Value Added Intellectual Coefficient (VAIC), on the financial performance and stability of 32 banks in Ghana from 2000 to 2015.	The findings indicate that while VAIC positively affects financial performance and stability, only Human Capital Efficiency (HCE) mirrors this relationship; Structural Capital Efficiency (SCE) negatively impacts both performance and stability, while Capital Employed Efficiency (CEE) increases performance but reduces stability.
Almahadin (2020)	Banking soundness-financial stability nexus: empirical evidence from Jordan	The main objective of this study is to examine the relationship between financial stability and banking soundness in Jordan.	The Jordanian financial system is stable, with robust banking soundness indicators positively impacting financial stability. A stable interest rate policy is crucial for maintaining this stability, and there is a strong positive relationship between financial stability and economic growth changes.
Koskei (2020)	Determinants of Banks' Financial Stability in Kenya Commercial Banks	The study aims to investigate the determinants of bank stability, specifically as proxied by asset quality, in the Kenyan banking sector.	The analysis reveals that liquidity ratio, inflation rate, and lending rate negatively impact banking stability, while loan growth and return on equity positively influence it; however, exchange rate, return on assets, and public debt have statistically insignificant effects on banking stability.

Xu et al. (2021)	Banking Efficiency and Financial Stability in Latin America	Explore relationships between banking efficiency and financial stability	Banking efficiency significantly impacts financial stability in Latin American countries; these two factors are interdependent.
Bhattacharjee (2023)	Does intellectual capital efficiency improve bank performance and financial stability? Evidence from Bangladesh	This study aims to investigate the impact of intellectual capital (IC) efficiency on financial and market performance and the financial stability of banks in Bangladesh.	The results indicate that while IC efficiency enhances banks' financial performance, it negatively affects market performance and increases insolvency risks; additionally, physical and financial capital are identified as primary contributors to bank performance and long-term growth, highlighting the need to develop an intellectual asset base to improve bank efficiency and stability.

3. Research Methodology

This study investigates the effects of financial stability efficiency on the financial sustainability of banks in Iran and Iraq and uses approaches such as neural networks and machine learning. Considering the complexity of the relationships between financial variables and their effects on the financial sustainability of banks, using deep learning techniques and new analytical models can help identify specific patterns and hidden relationships. In this study, Data related to banks' financial performance and financial stability efficiency components will be collected and preprocessed to be modeled by machine learning algorithms, such as neural networks. This approach not only provides more accuracy in the relationships between variables but also leads to the improvement of strategic decision-making in the financial management of banks. The results of this research, in addition to deepening knowledge about the impact of financial stability efficiency on banks' financial sustainability, will provide practical solutions to optimize the performance of banks in the two mentioned countries. Therefore, the main purpose of this study is to investigate the effect of financial stability efficiency on banks' financial stability and the financial sustainability of banksis in Iran and Iraq. Therefore, in this study, all banks listed in the Iran-Iraq Stock Exchange (census, 22 Iranian and 44 Iraqi banks) specified in Table 2 from 2000 to 2023 have been used.

Table 2. The names of Iranian and Iraqi banks accepted in the stock exchange

Iranian		Iraqi			
Name Bank	**Symbol**	**Name Bank**	**Symbol**	**Name Bank**	**Symbol**
Bank Mellat	VMELLAT	Al-Arabiya Islamic Bank	ARAB ISLAM	Al-Atta Islamic Bank	ATTA
Bank Tejarat	VTEJARAT	Asia Iraq Islamic Bank for Investment	ASIA	Mosul Bank for Development and Investment	MOSUL
Bank Saderat Iran	VBSADER	Ameen Iraq Islamic Bank	AMEEN	Al-Mansour Investment Bank	MANSOUR
Parsian Bank	VPARS	Al-Mashreq Al-Arabi Islamic Bank for Investment	MASHREQ	Al-Mustashar Islamic Bank for Investment	MUSTASHAR
Pasargad Bank	VPASAR	Al-Ansari Islamic Bank	ANSARI	National Islamic Bank	MELLI
Sina Bank	VSINA	Ashur International Bank for Investment	ASHUR	National Bank of Iraq	AHLI
Bank Eghtesad Novin	VNOVIN	Babel Bank	BABEL	North Bank for Finance and Investment	SHOMAL
Post Bank of Iran	VPOST	Bank of Baghdad	BAGHDAD	Al-Qabedh Islamic Bank for Finance and Investment	QABEDH

Middle East Bank	VKHAVAR	Cihan Bank for Islamic Investment and Finance	CIHAN	Al-Qurtas Islamic Bank for Investment and Finance	QURTAS
Karafarin Bank	VKAR	Commercial Bank of Iraq	TEJARI	Al-Rajeh Islamic Bank for Investment and Finance	RAJEH
Saman Bank	SAMAN	Dijlah & Furat Bank for Development and Investment	DIJLAH	Credit Bank of Iraq	ETEMAN
Ayandeh Bank	VAYAND	Dar Es Salaam Investment Bank	DAR ES SALAAM	Al-Aqeem Commercial Bank for Investment and Finance	AQLIM
Resalat Gharz Al-Hasaneh Bank	VSALAT	Economy Bank	EQTESAD	Sumer Commercial Bank	SUMER
Tose'e Credit Institution	TOSE'E	Elaf Islamic Bank	ELAF	Al-Taif Islamic Bank for Investment and Finance	TAIF
Refah Bank	VREFAH	Erbil Bank for Investment and Finance	ERBIL	Trans Iraq Bank for Investment	ABOR
Kosar Credit Institution	VKOSAR	Gulf Commercial Bank	KHALIJ	International Development Bank for Investment & Finance	TANMIA
Noor Credit Institution	VNOOR	Investment Bank of Iraq	ESTESMAR	United Bank for Investment	MOTAHED
Samen Credit Institution	VSAMEN	Iraqi Islamic Bank	MIRALLAH	Al-Warka Investment Bank	WARKA
Dey Bank	DEY	Middle East Investment Bank	SHARQ	World Islamic Bank for Investment and Finance	ALAM
Gardeshgari Bank	VGARDESH	Noor Iraq Islamic Bank for Investment	NOOR	Zain Iraq Islamic Bank for Investment and Finance	ZAIN
Shahr Bank	VSHAHR	International Islamic Bank	BEYNOLMELAL	United Arab for Money Transfer	TAHVIL
Sarmayeh Bank	SARMAYE	Al-Janoob Islamic Bank for Investment and Finance	JANOOB	Al-Atta Islamic Bank	ATTA
Melal Credit Institution	VMELAL	Kurdistan International Islamic Bank	KURDISTAN	Mosul Bank for Development and Investment	MOSUL
Iran Zamin Bank	VZAMIN				

Therefore, Iran and Iraq's[1] official banking and stock exchange[2] websites have been used to collect the research data. Therefore, in this study, the research model is as follows:

$$Fs_{it} = \alpha_0 + \beta_1 zscore_{it} + \beta_2 CAP_{it} + \beta_3 size_{it} + \beta_4 hhil_{it} + \beta_5 gown_{it} + \beta_6 lev_{it} + \beta_7 \mathrm{CFGR}_{it} + \beta_8 \mathrm{CFGR}_{it} + \beta_9 \mathrm{CF}_{it} + \gamma_{it}$$

In the above relation, FS: represents the financial stability of banks; Z-score the financial stability of banks; lev: represents bank leverage; size: bank size; hhil: is a measure of bank concentration; gown: to state ownership; cap: as capital adequacy variable, cfgr: growth of bank liquidity; incgr: growth of bank revenue; and γ_it: it refers to the component of disruption. In general, the method of measuring the research variables will be as follows.

3.1 Dependent variable: financial sustainability of banks

[1] http://www.cbi.iq, http://www.isx-iq.net, https://globaledge.msu.edu/globalresources/resourcesbytag/iraq, http://data.worldbank.org
[2] https://amar.org.ir/economic-accounts, https://tsd.cbi.ir/, https://databank.mefa.ir/, https://codal.ir/, https://www.tse.ir/

In which, the Fs_{it}financial sustainability of bank i in year t, the return on assets of the bank ROA_{it}i in year t is the ratio of the bank's net profit to the bank's total assets and the capital adequacy of bank CA_{it}i in year t is the result of dividing the basic capital into the bank's assets which is based on the capital adequacy regulations (2011) is disclosed in the company's financial statements, and finally, the $\delta(ROA_{it})$standard deviation of the return on bank assets is i in year t.

$$Fs_{it} = \ln(\frac{ROA_{it}+CA_{it}}{\delta(ROA_{it})}) \qquad (1)$$

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3.2 Independent variables

Financial Stability of the Bank

This index was first proposed by Hannan and Hanok (1988) and used by Boyd et al. (1993). Since then, various studies have used this index to examine the financial stability of banks (Iannotta et al. 2007; Tan and Floros, 2013; Tan et al. 2017; Ghosh, 2014). It considers the score, returns, volatility of returns, and the capital base of banks. A high Z-score indicates financial stability and the ability to absorb losses. Therefore, based on previous studies and in line with the study of Onumahand Doho (2019), the financial sustainability of banks will be indexed as a relationship (2).

$$ZScore = \frac{\left(ROA + \frac{E}{A}\right)}{\sigma ROA} \qquad (2)$$

ROA is the return on assets, E/A is the capital-to-asset ratio and σROA is the standard deviation of ROA.

Capital Adequacy Ratio

Based on the studies of Onumah and Doho (2019) and Mansourian Nezamabad et al. (2016). The capital adequacy ratio is one of the important criteria in assessing the financial health of banks and financial institutions. This ratio helps us understand how much risky assets a bank has covered with its capital. Therefore, the method of measuring the capital adequacy ratio as described by the relationship (3) is as follows:

$$CAP = \frac{Tier\ 1\ capital + Tier\ 2capital}{Risk\ weighted\ assets} \qquad (3)$$

Tier 1 capital includes the bank's principal capital (such as equity capital and accumulated profits) which is more resistant to losses. Tier 2 Capital includes other financial resources known as supplementary capital (such as long-term loans and public reserves), and Risk Weighted Assets are assets adjusted to certain proportions based on their level of risk. For example, risky loans have more weight. Therefore, according to the description, the capital adequacy ratio is a measure that shows whether a bank can cover the potential losses caused by its activities. Global standards and the rules of each country's central bank determine the minimum capital adequacy ratio to maintain a healthy and stable banking system. In Iran, this ratio has been set at at least 3% .In Iraq, the Capital Adequacy Ratio (CAP) is at least 8 percent, based on the laws and regulations of the Central Bank of Iraq (2019).

3.3 Control variables

Financial Leverage (LEV): Calculated from the ratio of total debt to total assets of the bank

(Onumah and Doho (2019);
SIZE: Calculated from the natural logarithm of the bank's total assets (Onumah and Doho, 2019);

Bank Concentration Criterion (HHIL): This variable refers to the analysis of market concentration or market share and shows how the market share is distributed among banks (Onumah and Doho, 2019);

State Ownership (GOWN): The percentage of institutional shareholders of the bank: this variable represents the percentage of government ownership in the bank and can have specific effects on the bank's policies and performance (Onumah and Doho, 2019);

Liquidity growth (CFGR) is calculated from the difference between the cash at the end and the beginning of the period divided by the cash at the beginning of the period (Yousefi Ghaleh Roudkhani et al., 2021);

Income Growth (INCGR): It is calculated from the difference between the income at the end of the period and the beginning of the period divided by the income at the beginning of the period (Yousefi Ghaleh Roudkhani et al., 2021);

Cash Ratio (CF): It is calculated from the ratio of total cash to total assets of the bank (Yousefi Ghaleh Roudkhani et al., 2021).

In this section, we describe the research methods used in this study. Due to the complexity of the subject under study, we have used a combination of advanced deep-learning techniques and machine learning algorithms .These methods include deep neural networks, supervised and unsupervised learning algorithms, and natural language processing methods that allow us to unravel hidden patterns in the data. To discover and create models with high predictive power. Our goal in using these advanced methods is to provide a comprehensive and accurate analysis of the available data and finally, to answer the research questions with the highest possible confidence level. Therefore, in this study, artificial neural network methods have been used to investigate the effects of financial stability efficiency and its effects on the financial sustainability of banks in Iran and Iraq.

Artificial Neural Networks (ANN): Artificial neural networks are utilized to model complex and nonlinear relationships between financial variables and financial sustainability. The network structure includes input, hidden, and output layers and uses different activation functions (Bahia, 2013). Recurrent Neural Networks (RNN) are suitable for processing time series data and maintaining long-term dependencies in financial data (Ilbeigipour al, 2022). Self-organizing maps (SOM) are used for unsupervised learning and reducing data dimensions, creating a two-dimensional representation of multidimensional data (Ilbeigipour al, 2022). Convolutional Neural Networks (CNN) are employed to identify complex, localized patterns in financial data and extract important features automatically (Wu et al., 2023). Deep Neural Networks (DNN) involve several hidden layers and can model complex, nonlinear relationships between financial variables (Saleem et al., 2022).

Clustering Algorithms: The Density-Based Spatial Clustering Algorithm of Applications with Noise (DBSCAN) detects irregular-shaped clusters and is consistent with noise in the data (Smiti and Elouedi, 2012). The K-Nearest Neighbor (KNN) algorithm is utilized for classification and regression, predicting a new bank's financial sustainability based on its nearest neighbors (Zhang et al., 2017). The K-mean algorithm divides banks into K clusters based on financial characteristics (Zhang and Xia, 2009).

Support Vector Machine (SVM) and Support Vector Regression (SVR): SVM is used to classify banks based on different levels of financial sustainability and isolates data in multidimensional space using hyperplanes. SVR predicts continuous values such as capital adequacy ratio and income growth (Amzile and Habachi, 2022). These methods are particularly important in analyzing the financial

sustainability of banks due to their ability to identify complex patterns and relationships in large, nonlinear data (Rodríguez-Pérez and Bajorath, 2022).

Decision Tree Algorithm, Random Forest, and Gradient Boosting: The decision tree hierarchically divides the data using the Gini criterion (Appiahene et al., 2020). The random forest increases the prediction accuracy by combining the results of several decision trees. Gradient boosting builds the models incrementally to reduce error. Each method has specific mathematical formulas that help with more accurate data analysis (Blockeel et al., 2023). These algorithms can determine the relative importance of each independent variable in financial sustainability (Doumpos et al., 2023).

Using these advanced methods to study Iran and Iraq's banking systems can provide deeper insights and more accurate forecasts, which will be useful for fiscal policy and strategic decision-making in both countries. These methods allow for a comprehensive analysis and accurate comparison of the banking systems, helping policymakers and bank managers to identify the key factors affecting financial sustainability and take the necessary measures to improve the bank's financial position.

4. Data and information analysis

One of the main challenges in comparative international financial studies is the differences in the countries' currencies. To overcome this challenge، the concept of arbitrage has been used. Using the principles of arbitrage، the different currencies of Iran and Iraq have become a common dollar unit. This approach allows for a more accurate comparison of financial data and considers the effects of currency fluctuations in the analysis. In this step, the data have been prepared using the Min-Max Scaling normalization technique. Therefore, the results of the descriptive statistics are as follows in Table 3.

Table 3. Descriptive statistics

Variable	Mean	Median	SD	Variance	Kurtosis	Skewness	Jarque-Bera
Financial Stability	0.466	0.467	0.164	0.027	-0.080	-0.066	0.000
Capital adequacy of the bank	0.447	0.451	0.156	0.024	0.022	-0.045	0.000
Bank Size	0.518	0.518	0.164	0.027	-0.046	-0.072	0.000
Title of the Bank's Concentration Criterion	0.471	0.472	0.152	0.023	0.160	0.027	0.000
Government Ownership	0.471	0.472	0.148	0.022	0.071	-0.023	0.000
Bank Leverage	0.505	0.504	0.149	0.023	0.003	-0.113	0.000
Bank Leverage	0.575	0.575	0.087	0.022	-0.026	-0.034	0.000
Growth of bank revenues	0.479	0.477	0.143	0.023	-0.001	0.065	0.000
Bank Cash Ratio	0.512	0.519	0.153	0.023	-0.014	0.106	0.000

Source: Research calculations

The presented descriptive statistics show that the studied banks in Iran and Iraq have an average situation regarding most financial and performance indicators. The mean and median of most variables are in the range of 0.45 to 0.52, which indicates average performance. This is true for financial stability, intellectual capital, capital adequacy, bank size, concentration, and government ownership. However, some indicators show a relatively better situation. For example, bank liquidity growth with an average of 0.575 and bank leverage with an average of 0.505 shows that banks have relatively good liquidity growth and financial leverage. Also, the bank's cash ratio with an average of 0.512, indicates a good liquidity situation in banks. Therefore, the dispersion of the data is moderate for most variables, with standard deviations ranging from 0.14 to 0.16. This shows that there is a

significant difference between the banks studied. A skewness close to zero for most variables indicates a relatively symmetric data distribution. However, a Jarque-Ber probability of 0.0000 for all variables indicates that the data distribution is not normal. Overall, these descriptive statistics paint a picture of a moderately performing banking system across most indicators, with strengths in liquidity and growth. However, there are challenges in terms of financial stability and capital adequacy. The non-normality of the data distribution also indicates that more advanced statistical analysis should use appropriate methods for non-normal data. Therefore, non-parametric statistical methods of machine learning and neural networks have been used in this research.

In this era, when the complexities of the financial system are increasing, it is important to evaluate and predict the stability of banks. This study aims to investigate financial stability and its performance for financial stability work in banks in Iran and Iraq from the new perspectives of neural networks and used machines. After collecting the relevant data, detailed and multi-step data preprocessing and software steps were performed, including outliers, missing data removal with interpolation techniques, and data smoothing in the interval [0,1]. In designing the architecture of neural networks, various and advanced methods are used, including artificial neural networks (ANN) with perceptron layer structure, deep neural networks with hidden layers, convolutional neural networks (CNN) with convolution and pooling layers, recurrent neural network (RNN) with LSTM and GRU units and self-organizing neural network (SOM) with unsupervised vision have been used. Optimization algorithms such as Adam and RMSprop are used to train these models, and L1/L2 and Dropout simulation model tuning techniques are used to avoid overfitting. Cross-validation methods have also been used to evaluate the performance of the models more accurately. This comprehensive and multi-dimensional use of neural networks provides the possibility of detailed analysis and financial stability of banks. The results related to neural networks are described in Table 4.

Table 4. Investigating the financial stability of banks using neural networks

Model	MASE	SMAPE	MPAE	MAE	RMSE	MSE	R^2
ANN	0.13	10.35	9.92	0.036	0.04	0.0023	0.95
DNN	0.14	10.30	10.20	0.039	0.05	0.0026	0.94
CNN	0.15	10.17	10.01	0.040	0.05	0.0025	0.94
RNN	0.16	10.91	11.05	0.043	0.05	0.0029	0.94
SOM	0.20	13.74	14.16	0.054	0.06	0.0046	0.90

Source: Research calculations

Based on the results presented in Table 4, it can be seen that the artificial neural network models have a significant performance in predicting and evaluating the financial stability of banks. The artificial neural network with a coefficient of determination of 0.95 has the highest accuracy among the models studied. This indicates the high ability of this model to explain changes in the financial stability of banks. Also, this model's mean square error and low root mean square error indicate the high accuracy of its predictions. Other neural network models such as deep, convolutional and recurrent neural networks also show similar performance with a coefficient of determination of 0.94. These results demonstrate the high performance of machine learning models in analyzing and predicting the financial stability of banks. The average percentage of absolute error and the average percentage of symmetric absolute error of these models are also within an acceptable range, indicating their ability to provide accurate estimates of the financial stability of banks. On the other hand, the self-organizing neural network with a coefficient of determination of 0.90 and higher errors shows a weaker performance than other models. This is due to specific complications in the structure of bank

financial data. However, even this model shows a significant ability to explain changes in the financial stability of banks. Overall, the results in Table 3 show that neural networks and machine learning approaches are powerful tools for assessing and predicting bank financial stability. These models can help bank managers and policymakers identify factors affecting financial stability and make strategic decisions to improve the performance and stability of the banking system. The results can also be used to develop early warning systems to identify systemic risks in the banking sector.

The presented descriptive statistics show that the studied banks in Iran and Iraq are in an average situation in terms of most of the financial and performance indicators. The mean and median of most variables are in the range of 0.45 to 0.52, which indicates average performance. This is true for financial stability, intellectual capital, capital adequacy, bank size, concentration, and government ownership. However, some indicators show a relatively better situation. For example, bank liquidity growth with an average of 0.575 and bank leverage with an average of 0.505 shows that banks have relatively good liquidity growth and financial leverage. Also, the bank's cash ratio with an average of 0.512, indicates a good liquidity situation in banks. Therefore, the dispersion of the data is moderate for most variables, with standard deviations ranging from 0.14 to 0.16. This shows that there is a significant difference between the banks studied. A skewness close to zero for most variables indicates a relatively symmetric data distribution. However, a Jarque-Ber probability of 0.0000 for all variables indicates that the data distribution is not normal. Overall, these descriptive statistics paint a picture of a moderately performing banking system across most indicators, with strengths in liquidity and growth. However, there are challenges in terms of financial stability and capital adequacy. The non-normality of the data distribution also indicates that more advanced statistical analysis should use appropriate methods for non-normal data. Therefore, non-parametric statistical methods of machine learning and neural networks have been used in this research.

Table 5. Investigating the financial stability of banks using machine learning

MODEL	SMAPE	MAPE	MAE	RMSE	MSE	R_Square	MASE
XGBoost	8.800	9.002	0.035	0.045	0.002	0.956	0.134
Random Forest	10.096	10.481	0.040	0.051	0.002	0.944	0.153
C5-0	13.608	14.024	0.054	0.068	0.004	0.904	0.205

The importance of variables in checking the financial stability of the bank

Variable	Random Forest	XGBoost	C5-0
CAP	100	100	40.035
CF	0.743	1.185	48.664
CFGR	0.375	0.630	27.340
gown	0.248	0.305	0.000
hhil	0.000	0.000	15.319
lev	0.695	0.365	15.516
size	1.289	0.857	30.959
zscore	2.258	2.276	100

Source: Research calculations

The results presented in Table 5 show that machine learning models, especially gradient boosting and random forest, perform very well in predicting and evaluating the financial stability of banks. The gradient boosting model shows the highest accuracy with a coefficient of determination of 0.9566, which indicates the ability of this model to explain more than 95% of the changes in the financial stability of banks. This model also shows the lowest error in various evaluation measures including MSE, RMSE and MAE, which indicates the high accuracy of its predictions. The random forest model also has a significant performance with a coefficient of determination of 0.9441. This model can help discover complex patterns in banks' financial data. Although the decision tree model

has a weaker performance than the other two models, it can still explain a significant part of the changes in the financial stability of banks with a coefficient of determination of 0.9045. These results show that machine learning approaches are powerful tools for analyzing and predicting financial stability in the banking industry. On the other hand, in examining the importance of variables, the results show that the capital adequacy ratio (CAP) is highly important in all three models. This emphasizes the importance of capital structure in the financial stability of banks. The Z score (Z-score) is the most important in the decision tree model, indicating this index's key role in evaluating banks' bankruptcy risk and financial stability. Cash flow (CF) and cash flow growth (CFGR) are also significant in the decision tree model, which emphasizes the importance of liquidity management in the financial stability of banks. On the other hand, variables such as bank size (size) and financial leverage (lev) have relative importance in different models. This shows that structural factors and financial risk management play an important role in the financial stability of banks. The variable of market concentration (hhil) is only of relative importance in the decision tree model, which can indicate the effect of market structure on the financial stability of banks. Overall, these results show that machine learning approaches are effectively used in evaluating and predicting the financial stability of banks. These models can identify key financial stability factors and help bank managers and regulatory bodies make strategic decisions and appropriate policies. Also, these findings can be used in developing early warning systems to identify systemic risks in the banking sector.

Advanced machine learning algorithms have been used to check the financial stability of Iranian and Iraqi banks. Before running the models, the financial data of the banks were standardized using Z-score normalization techniques to make the different scales of the variables the same and improve the performance of the models. In neural network-based algorithms, the neural structure was designed to include the input layer (with the number of neurons equal to the number of independent variables), hidden layers (with the number of neurons optimized for each model), and the output layer (with one neuron to predict financial stability). This structure allowed the models to discover complex and non-linear financial data patterns. Therefore, the results related to learning algorithms described in Table 6 are as follows.

Table 6. Investigating the financial stability of banks using learning algorithms

MODEL	MASE	SMAPE	MAPE	MAE	RMSE	MSE	R^2	Accuracy
Spatial clustering	0.004	0.218	0.217	0.086	0.106	0.011	1.000	99.995
K-Mean N	0.002	0.148	0.307	0.076	0.125	0.018	1.000	99.965
K-NN	0.071	3.341	3.373	1.260	1.552	2.408	0.990	99.027
SVR	0.183	8.493	10.377	3.225	5.896	34.767	0.916	91.624
SVM	0.183	8.493	10.377	3.225	5.896	34.767	0.850	85.000

Source: Research Calculations

The results presented in Table 6 indicate that spatial clustering algorithms and k-means clustering have exceptional performance in predicting and evaluating the financial sustainability of banks. Both models, with a coefficient of determination of 1 and accuracy close to 100%, demonstrate a superior ability to explain variations in banks' financial sustainability. These results suggest that these algorithms can effectively identify hidden patterns in financial data and provide a precise grouping of banks based on their financial sustainability status. Similarly, the k-nearest neighbor algorithm also shows good performance with a coefficient of determination of 0.9903 and an accuracy of 99.0276%. This model operates based on similarities between samples and has successfully understood the complex relationships between financial variables and provided accurate assessments of banks' financial sustainability. This result indicates that banks with similar financial characteristics likely

have similar financial sustainability statuses.

On the other hand, Support Vector Regression (SVR) and Support Vector Machine (SVM), although performing weaker than the first three models, are still capable of providing reliable assessments of banks' financial sustainability with coefficients of determination of 0.9162 and 0.8500 and accuracies above 90% and 85%, respectively. These models, which operate based on finding optimal hyperplanes to separate data, have established appropriate decision boundaries for evaluating banks' financial sustainability.

Thus, comparing the performance of these algorithms shows that clustering-based and nearest-neighbor methods perform better in evaluating banks' financial sustainability compared to SVM-based methods. This may be due to the high capability of these methods in identifying similar patterns and grouping banks based on shared financial characteristics. These results also indicate that the structure of banks' financial data likely has natural clusters that these algorithms have identified well.

These results demonstrate that machine learning algorithms are powerful tools for evaluating and predicting banks' financial sustainability. These models assist bank managers and regulatory bodies in identifying financial sustainability patterns, grouping banks based on risk, and predicting the future status of banks. Moreover, these findings can be used in developing early warning systems to identify systemic risks in the banking sector and improve the financial stability of the entire banking system.

The present study, using advanced neural networks and machine learning approaches, has shown high accuracy in predicting and evaluating banks' financial sustainability. This finding is consistent with the study by Berger and Bouwman (2013), which showed that banks with greater liquidity creation perform better during financial crises and exhibit greater financial stability. Furthermore, the current research results regarding the importance of variables such as the capital adequacy ratio align with the findings of Elbadry (2018), which demonstrated that the capital adequacy ratio negatively affects credit risk in Saudi banks. Moreover, the advanced machine learning algorithms in the present study demonstrated exceptional performance in predicting and assessing the financial stability of banks. These findings are congruent with those of Abdallah et al. (2019), who showed that high efficiency in Kenyan banks leads to significant improvements in financial stability. The ability of the algorithms in the current research to identify complex patterns and group banks based on shared financial characteristics aligns with the findings of Safarzadeh et al. (2019) regarding the importance of financial reporting quality in banking stability. The current study's results concerning the significance of various financial variables are consistent with the findings of Onumah and Duho (2019), who demonstrated that intellectual capital components have varying impacts on Ghanaian banks' financial performance and stability. In addition, the present findings regarding the importance of bank size and financial leverage are consistent with the results of Almahadin (2020), who found that bank health indicators positively influence financial stability in Jordan. The study by Koskei (2020) also supports your findings, indicating that factors such as the liquidity ratio, inflation rate, and lending rate affect banking stability in Kenya. Consequently, using advanced machine learning approaches, the present study adds new findings to the existing literature. The current study's models' ability to accurately predict banks' financial stability and identify key influencing factors can contribute to developing early warning systems for identifying systemic risks. This aligns with the objectives of previous studies such as Xu et al. (2021), which examined the relationships between banking efficiency and financial stability in Latin America. Also, the findings of the present study, considering the importance of various variables in the financial stability of banks, can assist policymakers and bank managers in strategic decision-making, which is consistent with the aims of studies like Bhattacharjee (2023), who investigated the impact of intellectual capital efficiency on bank performance and financial stability in Bangladesh.

5. Conclusion and implications

This study aims to examine the impact of financial stability efficiency on the financial sustainability of banks in Iran and Iraq. The statistical population includes all banks listed on the stock exchanges of Iran (22 banks) and Iraq (44 banks). Using this long time frame and extensive statistical population allows for a detailed examination of long-term trends and comparing the status of banks in both countries. Utilizing neural network and machine learning approaches, this study has provided deep insights into the factors affecting the financial sustainability of banks.

The results obtained from artificial neural networks and machine learning algorithms indicate that these models, with coefficients of determination above 0.94, can predict and evaluate banks' financial sustainability. This suggests the existence of complex and nonlinear relationships between financial variables and bank sustainability that traditional methods have been unable to identify. The ability of these models to learn complex relationships can aid in improving risk management and strategic decision-making in banks. For example, Gradient Boosting and Random Forest were able to identify hidden patterns in financial data and provide accurate predictions. On the other hand, the high importance of variables such as the Capital Adequacy Ratio (CAP), Cash Flow (CF), and Cash Flow Growth (CFGR) in various models indicates that capital structure and liquidity management play a vital role in the financial sustainability of banks. This finding is especially significant given the liquidity challenges that banks in Iran and Iraq have faced in recent years, highlighting the necessity for greater attention to cash flow management and strengthening capital structures. Additionally, the importance of variables such as bank size and financial leverage (lev) demonstrates that the financial structure of banks has a considerable impact on their financial sustainability.

Spatial clustering algorithms and k-means clustering, with accuracy close to 100%, showed exceptional performance in grouping banks based on their financial sustainability status. This result indicates that the banks studied in Iran and Iraq have natural clusters in terms of financial characteristics. Identifying these groups can assist in formulating supervisory strategies tailored to each group of banks. This finding leads to a differentiated approach in banking supervision, where policymakers can adjust their supervisory strategies based on the specific characteristics of each cluster of banks.

Therefore, the results show that the banks studied in Iran and Iraq are in a moderate state concerning most financial and performance indicators. This suggests there is considerable room for improvement in the banking systems of both countries. Given the economic and geopolitical challenges both countries face, improving the financial sustainability of banks can play an important role in overall macroeconomic stability. This finding also indicates that policymakers in both countries should focus on increasing efficiency and improving bank performance.

A comparison of the results between banks in Iran and Iraq shows that despite structural and regulatory differences, there are similar patterns regarding the factors affecting financial sustainability. This can pave the way for regional cooperation in banking supervision and exchanging experiences. For example, both countries can benefit from each other's experiences in implementing early warning systems based on machine learning.

Thus, the high capability of machine learning models in predicting banks' financial sustainability suggests that these methods can be powerful tools in early warning systems. This helps improve banking supervision and prevent financial crises in both countries. For instance, regulatory authorities can use these models to identify banks at high risk of financial instability and take preventive actions promptly.

In summary, the results of this study indicate that the use of machine learning approaches can

contribute to a deeper understanding of the factors affecting the financial sustainability of banks and improve risk management in the banking systems of Iran and Iraq. These findings can serve as a basis for formulating more efficient monetary and supervisory policies in both countries. For example, policymakers can use these results to fine-tune capital and liquidity requirements for banks.

Practical Policy Recommendations for Iranian Monetary Authorities

1. Develop and implement early warning systems based on machine learning to identify systemic risks in banks.
2. Strengthen supervision over banks' liquidity management, emphasizing cash flows and their growth.
3. Revise capital adequacy regulations and formulate new standards in line with the findings of machine learning models.
4. Establish incentive mechanisms for banks that demonstrate higher financial sustainability based on predictive models.

Practical Policy Recommendations for Iraqi Monetary Authorities

1. Utilize clustering algorithms to classify banks and formulate supervisory policies tailored to each group.
2. Focus on improving risk management in smaller banks, considering the importance of bank size in financial sustainability.
3. Enhance regional cooperation, especially with Iran, in exchanging experiences and technical knowledge related to using artificial intelligence in banking supervision.
4. Establish a specialized research center to continuously study banks' financial sustainability using advanced machine learning methods.

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IJAAF; Vol. 9, No. 2, Spring 2025, Serial 31

Iranian Journal of
Accounting, Auditing & Finance

Ferdowsi University of Mashhad

Quarterly

RESEARCH ARTICLE

The Distortions of Machiavellianism, Containment Solutions and Effect on the Quality of Audit Judgments

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How to cite this article:
Habibzadeh, S. , Alinezhad Sarokolaei, M. and Zeynali, M. (2025). The Distortions of Machiavellianism, Containment Solutions and Effect on the Quality of Audit Judgments. Iranian Journal of Accounting, Auditing and Finance, 9(2), 135-156. doi: 10.22067/ijaaf.2025.45229.1443
https://ijaaf.um.ac.ir/article_45229.html

ARTICLE INFO

Article History
Received: 2024-02-17
Accepted: 2024-08-21
Published online: 2025-04-15

Keywords:
Cognitive, Knowledge Factors, Machiavellian Twists, Preventive and Regulatory Factors, Quality of Audit Judgments

Abstract

The present research, using the qualitative method of background, has tried to identify the effective background and interfering factors in the creation of Machiavellian tendencies of auditors and to calculate the strategies and consequences of limiting the Machiavellian characteristics of auditors. The statistical population of the current research is composed of expert and experienced university professors in the field of auditing, partners of auditing institutions, managers of auditing organizations, and other members of the community of certified accountants. The period of the study implementation is between 2021 and 2022. Using the purposeful mixed sampling method, 14 in-depth and semi-structured interviews were conducted until theoretical saturation was reached. Also, the structural equation modeling approach was used to measure the model's validity, and PLS software was used to fit the model. The findings show that the effective and intervening factors in creating Machiavellian tensions include preventive and supervisory factors, cultural, environmental, and social factors, structural and technical factors, financial and economic factors, and perceptual, human, and knowledge factors. Also, providing cultural and social platforms, structural and technical reforms, economic improvement and political communication, strengthening the knowledge and skill of the workforce, and providing a legal and regulatory platform are among the strategies to contain Machiavellian distortions. In addition, cultural and social influences on the auditing profession and laying the foundation for increasing audit quality are essential consequences of enclosing Machiavellian distortions.

https://doi.org/10.22067/ijaaf.2025.45229.1443

CC BY

NUMBER OF REFERENCES
36

NUMBER OF FIGURES
1

NUMBER OF TABLES
7

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

Communication between auditors and stakeholders is not beyond the limits of human communication (through symbols and signs), and in recent decades, not understanding this issue has been challenging for the audit profession because the economic units are the geometric place and the meeting point of the contracts. The community of different stakeholders forms, and each has different information needs and interests. Since the audit is a process based on social relations, it has a decisive role in reducing the conflict of interests and agency costs. When the Machiavellian behavioral strains of the auditors' judgments affect the audit objectives, the effectiveness and added value of the audit services will not be realized (Saladrigues and Grañó, 2014; Sahla and Iryanie, 2018). According to Hamilton and Smith (2021), the limitations of auditors' behavioral strains, such as opportunism, limited individual emotions, pessimism, recklessness, self-centeredness, psychotic abuse, antisocial personality, and extreme attention-seeking, are not clearly explained in accounting and auditing standards. At the same time, it has influenced the quality of auditors' essential judgments. According to Sikka et al. (1998), the nature of each of these characteristics has made it difficult to remove the behavioral strains that affect auditors' judgments. The attributes of Machiavellianism have created a universal and unavoidable phenomenon in auditors' judgments and made the understanding of this term somewhat ambiguous (Pranyanita and Sujana.,2019).

Hammersley and Ricci (2021) have divided auditors' performance in the current complex business environment into program-oriented and goal-oriented. The traditional and program-oriented approach focuses on the evidence-gathering procedures resulting from auditors' planning, and the goal-oriented approach focuses on the purpose of the task. In a goal-oriented approach, auditors collect evidence for improved professional judgment and more effectively track evidence than program-oriented auditors. As a result, audit quality is improved due to the flexibility of goal-oriented auditors in response to users' information needs in evaluating evidence. Although auditors' planning in the audit process helps to obtain and collect reliable evidence, the negative characteristics of Machiavellianism such as lack of feeling of shame or regret, failure to learn from past experiences, weakness, and insufficiency in emotion and excitement, distance from others, anxiety, and high stress can confuse critical judgments of auditors in presenting a fair report (Houghton et al., 2011).

Audit quality is an infinite and relative phenomenon, which research and investigation do not stop increasing, and more research adds to its evolution in implementation. Several factors have been investigated in previous studies to improve audit quality; However, one of the verifiable dimensions that has been given less attention in previous research in a deep and structured way is limiting negative personality traits and Machiavellianism to improve the quality of auditors' judgments. The characteristics of Machiavellianism have created a universal and unavoidable phenomenon in auditors' judgments and have affected the usefulness of financial reports for users (Pesudo et al., 2023).

For this purpose, reaching a common understanding through the theoretical insights of the auditing profession's experts can help formulate and revise the supervisory regulations and the auditors' professional code of conduct to enclose the features of Machiavellianism. Research in this area has focused on identifying the relationship between Machiavellianism and unethical behavior among auditors. In contrast, an in-depth and structured study has yet to investigate the causal and intervening factors in creating Machiavellian distortions of auditors and the bases and strategies for limiting this abnormal phenomenon. Also, the potential consequences of such behavior for the auditing profession are unclear. On the other hand, the importance of examining cultural and social issues and structural and technical factors in creating auditors' Machiavellian tendencies and identifying the most effective strategies for promoting ethical behavior among auditors to limit their behavioral tendencies is visible to everyone. Hence, the present research provides a broader view of why auditors have Machiavellian

behavior in their assignments and whether such biases affect their professional judgments. In this regard, the current research, while conducting the questions and answers of the evaluator, is trying, by combining qualitative analysis and experimental test (through the mixed research method), to calculate the factors affecting the Machiavellian tendencies of auditors in Iran and about the adaptation of the views of experts in the auditing profession. Provide platforms and strategies to improve the quality of auditors' judgments. The philosophy of conducting this research is based on alternative or non-mainstream views. It is considered interdisciplinary research that combines sociology with the auditing profession so that the resulting theories are an alternative to the realistic perception of social relations. For this purpose, theoretical foundations, experimental background, research methodology, findings, discussion, and conclusions will be presented in the continuation of the research.

2. Theoretical principles

Professional associations such as the International Organization of Supreme Audit Institutions and the International Federation of Accountants since 2016, with the slogan of effectiveness instead of assurance, argue that reporting compliance or non-compliance (zero and one) and confirmation or rejection of historical information do not have the necessary effectiveness for users. Responsible for providing financial reports that are the basis of future forecasts and have extended this role and responsibility to auditing standards. The American Institute of Certified Public Accountants (AICPA) (2020) stated in its report that its demand will decrease if auditing cannot generate money from the present to the future. Serafeim and Ioannou (2013) also believe that auditors should always consider themselves a part of society, feel responsible towards society, and act independently of the company's direct interests to improve public welfare. To fulfill this role, auditors' personality traits must follow the professional code of conduct within the practical ethics framework. In contrast, the experimental and field evidence of auditors' performance shows the occurrence of the Machiavellian personality phenomenon in essential judgments. These personality traits have been identified with pessimism, recklessness, and the influence and dominance of a person or group against themselves and persuading the other party to secure personal interests (Sharpe et al., 2021). Also, sometimes Machiavellianism has had entirely negative characteristics, such as ruthlessness, deception, or self-centeredness, which is immensely worrying for maintaining the credibility of the auditing profession (Zettler and Solga, 2013).

International auditing standards describe three factors as the fraud triangle and predict the possibility of fraudulent financial reporting (Public Company Accounting Oversight Board (PCAOB), (2005); International Accounting Standards Board (IAASB), (2009). The first two factors are opportunity and motivation/pressure, which are widely recognized as factors influencing the occurrence of cheating (Erickson et al., 2004; Graham et al., 2005; Wells, 2001), while the third factor is attitude and rationality, which can be related to the Machiavellian characteristics of people (Hogan et al., 2008; Wells, 2004). Therefore, the existence of negative characteristics of auditors' Machiavellianism has negligible similarity with fraud. In contrast, the auditors themselves oversee disclosing and providing reasonable assurance about the absence of material misstatements in the financial statements. Based on this, we can acknowledge the importance of addressing the issue of Machiavellian characteristics of auditors. Auditors should avoid ineffective behavior because it affects the report's reliability and, as a result, can harm the public interest. The tendency to inefficient behavior can be adjusted by identifying and limiting some causal factors caused by auditors' personality aspects (Murphy, 2012).

Social sciences are always mixed with interpretation, and the disciplines discussed in these

sciences are based on subjective perceptions and are not objective. The possibility of bias in judgments has been possible. In other words, everything that happens in service professions is based on essential judgments. In scientific schools related to social sciences, neo-realist and neo-liberal views are proposed, which are based on progressive ideas and are at the opposite point of critical theory. Realist theorizing takes the existing order for granted, while critical theorizing seeks to disrupt the apparent order and change what it is (Mujiono and Jonnardi, 2022). The views governing the theory of realism are based on the interests of the majority, and its goal is to meet the expectations of the dominant groups. On the other hand, critical theory consistently reveals and destroys hierarchical structures that affect small groups in society. In other words, critical theory also has an ethical position whose roots are in providing minority rights. The reduction of inequalities, the establishment of distributive justice, diversity instead of exclusivity, and pluralism and differences are among the points of attention of critical theorists in scientific analysis. The followers of the critical school believe that the typical behavior patterns among the specialists of that society prevent the formation of a specialized and competitive society (Linklater, 2010).

2.1 Machiavellian biases and the quality of auditors' judgments

The level of society's expectations from auditors of financial statements day by day coincides with their social responsibility. Meanwhile, auditors, due to one of the characteristics of Machiavellianism (not being social), do not accept this responsibility of harming financial health and social health and consider it related to not addressing the issue of social responsibility in auditing standards. Auditors admit that the audit of social and environmental responsibilities is expensive, challenging (administratively), retrospective, and often needs more accuracy and timeliness (Castka et al., 2020). Besides not helping the dynamics of the profession and gaining users' trust in financial reports, the antisocial personality that some auditors include in their judgments also limits the application of professional values in a supervisory system. Therefore, recognizing and enclosing Machiavellian distortions is necessary for a high-quality audit and helps to increase trust, optimal allocation of resources, and the quality of financial reporting and the profession's effectiveness. In the current situation and era, Machiavellian twists in service professions based on social relations are considered a severe threat to public interests, especially capital market actors, and their destructive effects on countries' economies can last for years (Brown et al., 2016). According to Bloomberg (2003), due to the influence of auditors' personality traits in critical judgments, dissatisfaction with auditors' performance and lawsuits against them have increased in recent decades. Not paying attention to social responsibilities and conservative reporting due to Machiavellian characteristics reduces the risk of litigation and lawsuits against auditors and fuels the problem of information asymmetry (Arens et al., 2012). Machiavellianism refers to a personality trait characterized by manipulation, collusion with clients, biased reporting, cynicism, and focus on personal interests in the auditing profession, making people more involved in unethical behavior. Machiavellian characteristics have negative effects that can weaken the auditor's integrity and impartiality when making essential judgments. Auditors who behave this way reduce the quality of the audit report. Machiavellianism is characterized by a lack of concern for personal relationships and a disregard for conventional morality, with low ideological commitment (Sahla and Iryanie, 2018). According to Patton (2014), this characteristic makes individuals prioritize results over processes. In addition, Machiavellian traits are often associated with manipulative attitudes to achieve personal goals. This characteristic is detrimental to professions, especially auditing because it is associated with professional judgments. The higher the level of Machiavellianism, the more likely the auditor will engage in unethical actions (Cahyono and Sudaryati, 2023). The above content shows that addressing the issue of increasing audit quality by limiting the Machiavellian characteristics of auditors can improve the quality of auditors' judgments

while gaining society's trust, leading to the growth and promotion of the auditing profession. Therefore, the central question of the research is raised as follows: what is the appropriate model for enclosing the Machiavellian characteristics of auditors?

The results of surveys in the last few decades have indicated its existence and continuity in most parts of the world.

Pesudo et al. (2023) showed that the characteristics of Machiavellianism have a negative effect on the quality of auditing, and auditors' competence has a positive effect on the quality of auditing. Also, the motivation variable does not affect audit quality.

Cahyono and Sudaryati (2023) concluded that an ineffective audit process reduces the quality of audit results, which may lead to public trust in the auditing profession. Therefore, a Machiavellian attitude among auditors can lead to negative consequences, including unethical behavior. To prevent auditors from unethical behavior, it is vital to promote fundamental values and norms in the auditing profession as a source of ethical guidance for auditors.

Mujiono and Jonnardi (2022) showed that the audit fee negatively affects the auditor's independence, and the Machiavellian nature negatively affects the auditor's independence. Also, professional ethics as a moderating variable affects the relationship between audit fees and auditors' Machiavellianism.

Prativi (2021) showed that the negative characteristics of Machiavellianism affect the complexity of auditors' tasks as an inefficient behavior. Also, the Machiavellian trait affects the source of control as the background of the auditor's ineffective behavior in the audit department.

Putu et al. (2020) studied the mediating effect of ineffective auditor behavior on Machiavellian personality and time budget pressure on audit quality. The results showed that auditor ineffective behavior ultimately affects audit quality through Machiavellian characteristics. In contrast, an auditor's ineffective behavior pressures the time budget, which affects the quality of the audit in a completely partial way.

Pranyanita and Sujana (2019) concluded that the nature of Machiavellianism, time budget pressure and external control sources positively affect audit inefficiency. In comparison, the internal control center has a negative effect on audit inefficiency. Auditors' asymmetric behavior is one factor affecting this behavioral deviation. Inefficient audit behavior can reduce audit quality.

Wijayanti (2018) investigated the effect of Machiavellian nature, emotional intelligence, spiritual intelligence, and understanding of professional ethics codes of accountants on ethical behavior in auditing. The results showed: 1) Machiavellian nature affects the ethical behavior of auditors, that the higher the level of Machiavellianism, the greater the tendency to perform unethical actions, 2) Spiritual intelligence has a positive effect on the ethical behavior of auditors, and 3) Understanding the codes of professional ethics of accountants. It has a positive effect on the ethical behavior of auditors, and emotional intelligence does not affect the ethical behavior of auditors.

Tricky et al. (2017) showed a significant relationship between Machiavellianism and relativism, idealism, anti-intellectualism, and social bias. Also, similar personality traits regarding climate between Canada and the United States were not observed.

Saputri and Wirama (2015) showed that Machiavellianism and personality type significantly affect the auditor's ineffective behavior. Audiences with high Machiavellian values and a negative personality type tend to perform ineffective behaviors.

Murphy (2012) showed that individuals with more Machiavellian characteristics are likelier to give false reports, and auditors who give false reports experience negative emotions (affect). Also, auditors with Machiavellian characteristics are not affected by Machiavellian characteristics and feel less guilty when reporting falsely.

3. Research methodology

The approach and logic of data collection in this research is of analogical induction type. The study was conducted from 2022 to 2023, and the research method is of a mixed type, describing how to carry out the methodology of each section.

3.1 Qualitative section

In the qualitative part of the research, to identify the effective factors that create the characteristics of auditors' Machiavellianism, as well as to explain the platforms and strategies that are effective in enclosing this phenomenon from the foundation data method and due to the desire for elitism of the investigated phenomena, a semi-structured interview tool has been used. The statistical population of the current research, to conduct interviews and statistics of the conceptual model of the research, consists of expert and experienced professors in the field of auditing with scientific and executive expertise, senior managers and technical managers of auditing organizations, as well as partners of private sector auditing institutions and members of professional associations and institutions supervising the profession. Audits are formed like the Supreme Council of the Society of Certified Accountants. Also, due to the exploratory nature of the research, the purposeful mixed sampling method or the conscious selection of specific participants has been used. This method is due to the use of expert samples in different groups and the aim of theoretical saturation in presenting a conceptual model (Teddlie and Yu, 2007). To select the sample to the extent of sufficiency and with the aim of theoretical data saturation, 14 in-depth and semi-structured interviews were conducted with a weighted average of 36 minutes. The questions have been designed according to the research objectives and used with the advice and approval of 5 university professors in the auditing field. In the interview with the experts, six questions were asked to reach theoretical saturation, and an example of the compiled questions is in Table 1:

Table 1. Research questions

No	Questions
1	In your opinion, what are the effective and interfering factors in creating Machiavellian characteristics of auditors?
2	What strategies and platforms do you suggest limiting the negative characteristics of auditors' Machiavellianism? Which institution or authority should provide and monitor These platforms and strategies?
3	If an approach is presented to limit the Machiavellian characteristics of auditors, what could be its consequences on the auditing profession? (Separately, the consequences should be stated).
4	Please state whether important things have yet to be mentioned in limiting Machiavellianism's negative characteristics and the auditors' monopoly.

After the interviews, data collection, analysis, and construction were done simultaneously, and the model indicators in this section were selected codes, central codes, and open codes to analyze textual and unstructured data using MAXQDA Software. was determined. The interview concepts were classified and coded in open coding by reviewing the collected data set to determine the codes and distil and summarize the information. In the next stage (axial coding), to create a relationship between the categories listed in open coding, the principal axes in the data set were identified around the axis of the two main categories to the Machiavellian distortions of the auditors. In the last stage, selective coding, selecting and categorizing the main categories, systematically linking each concept with other categories, and confirming the validity of the relationships between the main and sub-components were done. In this way, the central category, the characteristics of Machiavellianism, was systematically related to other categories, and the categories that needed more improvement and development were modified. Audio recording devices were used during the interviews after

coordinating with the interviewees to ensure the validity of the qualitative data and provide the possibility of a detailed examination of the raw data. By producing the interview text verbatim, the resulting rich, deep, and transparent data can be made. Also, to check the reliability of the data in this section and ensure the coders' correctness and the data's internal validity, Cohen's kappa test was used in SPSS Software, the results of which are presented in the research findings section.

3.2 Quantitative section

In the quantitative section, after preparing the questionnaire, the questions are based on concepts extracted from interviews with experts and emerging components. In other words, the research data collection tool in the quantitative section a researcher-made questionnaire based on the items extracted from the qualitative section, including six main questions with 121 items based on a 5-point Likert scale (from no impact to high impact) and with the approval of 5 experienced professors in The statistical population of the quantitative part also includes: members of the interviewed panel of the qualitative part, other university professors, technical managers and senior auditors of the audit organization and private sector audit institutions, financial analysts, official judicial experts and finally doctoral and master's students in the field Accounting and auditing consists of 280 people. Using Cochran's formula, 162 questionnaires were distributed, of which 156 items were collected, and 154 items were evaluated as usable. Cronbach's alpha test and KMO index, which were analyzed in the research findings section, were used to check the validity and reliability of the questionnaire. Further, to validate the conceptual model of the research, the structural equation modeling approach was used using Smart PLS3 software to evaluate the influence and coefficients of each of the implicit and explicit components of the conceptual model.

4. Research findings

The current research was conducted with at least 14 experts in our country's auditing profession, and their valuable opinions were analyzed. Table 2 shows the statistics of research participants in the qualitative section. As can be seen, most of the experts participating in the research are experienced university professors. Each of these experts, with their knowledge and long experience, is a valuable treasure for our country's accounting and auditing profession, and the current research is based on the experts' opinions and scientific analytical achievements. He is trying to find a suitable approach to contain the Machiavellian tendencies of statistical auditors. It is worth mentioning that some experts are both in the field of universities (membership in the faculty of universities) and in the category of partners of auditing institutions, which are grouped separately to match the total number of interviews with the statistical sample of the qualitative section.

As mentioned, 154 questionnaire items were analyzed in the quantitative section to model the structural equations, and Table 3 shows the descriptive statistics of the participants in this section. As can be seen, about 27% of the respondents are women, and 73% of them are men. About 5% of the statistical sample in this department have the scientific rank of associate professor, 25% have the scientific rank of assistant professor, 33% have the degree of specialized doctor, and 56% have contributed with a master's degree. Also, 52% of the participants in this section have more than ten years of executive experience in the audit field, and 48% have less than ten years of executive experience. The leading professional category of auditors participating in the quantitative section and completing the questionnaire are senior auditors, with about 30%, and audit supervisors, with 14%.

Table 2. Statistics of the participants of the qualitative part of the research

Filed area	No.	Scientific rank			Education		Executive experience level (in years)	
		Professor	Associate professor	Assistant professor	Master's	PhD	Less than 10	More than 10
Experienced university professors with scientific and executive expertise	6	3	3	-	-	6	1	5
Senior managers and technical managers of the auditing organization	2	-	1	1	-	2	-	3
Partners of audit institutions	2			2	-	2	-	2
Other members of the community of certified accountants	4	-	-	4	3	1	-	4
Total	14	3	4	7	3	11	1	13

Table 3. Statistics of the participants of the quantitative part of the research

Filed area	No.	Gender		Scientific rank				Education			Experience level (in year)		Professional position				
		Male	Female	Professor	Associate professor	Assistant professor	No rank	PhD	Master's	pther	Less than 10	More than 10	Senior auditor	Technical manager	Supervisor	Partner	No position
Panel members of the quality department	8	7	1	2	2	4	-	8	-	-	-	8	-	-	-	-	6
Education Board members	20	12	3	-	4	18	-	22	-	-	6	16	1	2	5	1	10
Auditors of auditing organizations and private sector institutions	58	32	31	-	2	15	31	19	30	14	13	50	32	5	8	3	2
official court expert	7	7	-	-	-	3	4	2	5	1	2	5	-	2	-	-	4
Financial analysts	26	18	8	-	2	8	20	13	11	5	11	15	3	-	2	-	27
PhD students	35	25	10	-	-	-	39	1	24	-	17	11	11	2	4	-	21
Total	154	101	53	2	10	48	94	65	70	20	49	105	47	11	19	4	73

The text of all 14 interviews was analyzed in MAXQDA software for categorization and sorting, and 119 primary concepts were identified for influential and interfering factors, foundation, and strategies, as well as the consequences of enclosing Machiavellian distortions. Table 4 shows the frequency of concepts extracted from the MAXQDA software.

Table 4. Frequency of research concepts

The main categories of research	Subcategories	No. of concepts	Frequency percentage
Effective and interfering factors in creating Machiavellian tensions	Cultural, environmental and social factors	16	22.5
	Structural and technical factors	10	17
	Financial and economic factors	6	10
	Perceptual, human and scientific factors	16	27.5
	Preventive and regulatory factors	13	23
	The sum of the concepts	58	100
Encapsulation platforms and strategies Machiavellian twists	Cultural and social background	5	11
	Structural and technical reforms	6	11
	Economic improvement and political connections	4	9
	Strengthening the knowledge and skills of human resources	8	19
	Providing a legal and regulatory platform	21	50
	The sum of the concepts	44	100
Consequences of confinement characteristics of Ma chiavellianism	Cultural and social consequences on the auditing profession	7	41
	The platform for increasing audit quality	10	59
	The sum of the concepts	17	100

The structural equation approach was used for validation. In structural equation modeling, the standard criterion for establishing convergent validity at the construct level is the extracted average variance. The results of this section are presented in Table 5. As can be seen, the values of the factor loadings of the hidden components of the model are more than 0.4, which is statistically significant and confirms the appropriate description of the variance of the corresponding indicators. Also, the average extracted variance of each component is more than 0.4, which shows that the fitted model has good convergent validity and confirms the confirmatory factor analysis.

Table 5. Results of confirmatory factor analysis of questionnaire questions

Components	Item	Factor load	Standard error	AVE
Cultural, environmental and social factors	Religious beliefs and convictions	0.687	0.074	0.579
	Imposing personal opinions resulting from individualism			
	Personality type and social culture of auditors			
	Lack of real understanding of the importance of the consequences of unfair reporting			
	Discrimination and lack of meritocracy for the right work			
	Rampant unemployment			
	There is an uncertain future.			
	Instability of practical and normative ethics in society			

	Replacing anti-values with current moral and behavioral values in society			
	Lack of comprehensive definition of responsible auditor			
	Work environment conditions and conditions governing it			
	Basic mental conflicts in Machiavellian twists			
	Disregarding the auditors' social goals			
Structural and technical factors	Special features of the profession	0.508	0.073	0.520
	Refusal to disclose economic facts due to irresponsibility			
	The inadequacy of the audit committee members regarding expertise has made monitoring the auditors' performance challenging.			
	Global developments and specialization of affairs			
	Overriding the environment of the auditing profession			
	Management style, reporting quality and reporting tools used			
	The complex nature of the distortions that cause the auditors to throw away clean accounts			
	Inappropriate feedback from managers regarding the audit clauses reduces the motivation of auditors to audit the content.			
	Lack of deficit or lack of standards in the field of information technology			
	The deviation of the environmental growth of the owners in terms of information technology and the lack of sufficient expertise of auditors in this field			
Financial and economic factors	Auditors and auditing institutions are worried about maintaining their company activity, which affects their independence.	0.545	0.072	0.536
	The downward pressure on audit fees			
	Disruption of the state of the national economy and lack of income stability			
	Dependence on the rentier economy			
	Failure to meet personal needs in conditions of uncertainty			
	Acute inflation in the country's economy has practically affected financial information, reports, and handling.			
	Conservatism and channelized treatment of auditors: 1- The conservatism of auditors during the audit tenure is caused by conservatism tendencies (for example, auditors in the last two years of their tenure in the company act bolder and stricter than in the first two years. In other words, in the last year of tenure, the independence of auditors increases)/ 2- The conservatism of auditors in the shadow of customer retention (for example, most banks are not in good condition, but can auditors clearly state this fact in their reports? Disclosing this issue has negative consequences for society)			
	Sometimes, there is a conflict between the financial knowledge of auditors and the delegation of responsibility to them.			
Perceptual, human and scientific factors	Auditors' lack of responsibility for the development of information technology.	0.761	0.071	0.659
	Lack of experienced and trained manpower			
	Sometimes, the judgments of the auditing profession are not based on the mastery of concepts and judgment tools, and there is a misappropriation of judgment.			
	Personality factors such as high stress and anxiety			
	Little experience for a lot of work			
	Influential personal characteristics: auditor's level of optimism or pessimism, emotions associated with stress and worry			

	Psychological and emotional characteristics			
	Personal pressure and intimidation and expectations of work and social situation (special side)			
	Inadequate investment in specialized human resources under the pretext of low wages			
	Lack of access to sufficient and experienced human resources			
	Improper application of standards due to poor training and insufficient skills			
	Personal and educational characteristics			
	Managers' inattention to solving the ambiguity and solving the problem of the audit clauses			
	Lack of creative mind in creating service innovation			
Legal and regulatory factors	There is insufficient monitoring of the Machiavellian behavior of auditors	0.452	0.074	0.445
	Prescriptive pricing of auditors' services			
	The level of importance in the audit causes auditors to be indifferent in dealing with violations lower than this level, according to the company's size.			
	Lack of disciplined and restraining financial laws			
	The standards limit the auditors' scope of responsibility and cause the auditors to be too conservative.			
	Absence of a framework for accountability to stakeholders and prosecution against auditors			
	Lack of insurance coverage for auditors, which increases the fear of disclosing economic consequences			
	Excessive interpretability of laws and regulations and incorrect inferences from them			
	Lack of sufficient supervision by professional associations and supervisory bodies on auditors' behavior, thoughts and ethics			
	Lack of mechanism for information transparency certificate			
	Outsourcing the work of auditors to third-party companies			
	Deficiency in legal requirements and its effect on auditors' conservatism			
Platforms and strategies for limiting the features of Machiavellianism				
Cultural and social background	Improving communication and creating a common language between audit committees, constituent shareholders, executives and internal auditors	0.502	0.073	0.543
	Compliance with ethics and professional code of conduct regarding price cuts and avoiding utilitarianism			
	Reducing social pressure on auditors			
	Increasing the role of auditing and accounting professionals in the financial reporting ecosystem			
	Understanding the technical, behavioral and personality fields of auditors			
Structural and technical reforms	Rating of auditors (every audit is not necessarily allowed to audit every company of any size), like the engineering system	0.531	0.071	0.602
	Foresight and expressing the consequences of audit clauses in the company's future activities			
	Control of environmental factors			
	Prevention of fraud through full attention to corporate governance mechanisms			
	Establishing a mechanism for the health of financial reporting			
	Auditors are selected based on experience in a particular industry, industry-specific rules and regulations, and business conditions.			

Economic improvement and political connections	Decision making and informed judgment in an economic environment in investments	0.521	0.072	0.594
	Creating a competitive environment in the economy and real privatization			
	Controlling the influence of some political governments in developing standards and laws			
	Increasing the efficiency of financial markets			
Strengthening the knowledge and skills of human resources	Continuous training of auditors to increase expertise and technical skills	0.511	0.073	0.610
	Recognition and awareness of external and internal factors by auditors			
	Employing expert human resources for standardization in the auditing organization			
	Full adherence to professional code of conduct and inner independence			
	Accrediting and equipping auditors: Accredit auditors with moral and value standards and invest more in their continuous education.			
	Training auditors in the field of today's businesses and adaptation and progress in the field of information technology			
	The priority of the content over the form of audit committees that are not among the people below the key of the CEO and the major shareholder			
	Strengthening audit institutions in terms of tools and experienced human resources			
Providing a legal and regulatory platform	Providing the necessary legal basis for the implementation of judicial accounting	0.494	0.071	0.566
	Limiting the continuation of the activity of institutions by selling comments			
	Classification and ranking of auditing institutions in terms of the size of the companies under consideration and the volume of reports provided			
	Resolving the concern of the continuity of auditors' activities by defining the fees and how to change auditors			
	Clarity in laws and regulations and determination in their implementation			
	Increasing the quality of financial reporting and reducing existing limitations in reporting			
	Rating of auditors and peer evaluation of quality indicators of auditors			
	Determining indicators for how to choose an auditor			
	Applying heavy fines for auditors' negligence			
	A structured and logical review of audit fees and transparency of variables that affect audit fees and contracts.			
	The need to review auditing standards through foresight and expressing the economic consequences of companies			
	Stating the economic problems of the company in the audit paragraphs alone is not enough, and its consequences on the company's future activities should also be determined.			
	The stronger role of professional and supervisory associations such as the Capital Market and the Society of Certified Accountants and the creation of a committee by these associations for the implicit training of auditors.			
	Strengthen regulatory and basic laws (such as trade law)			
	Hearing the auditors' concerns by the public accountants' society and the audit organization and expressing them in the cabinet and government supervisory meetings.			

	Creating coercive power to answer auditors in front of users in case of negligence and moving in line with the social goals of companies			
	Separation of audit reports from the legal inspector to differentiate the importance of reports and the volume of proceedings due to the amendment of the commercial law			
	An independent body consisting of various stakeholders and professional auditing organizations should be formed to control the Machiavellian tendencies of auditors.			
	Supervision of audit fees			
	Paying attention to the personality aspects of official accountants at the time of joining the society			
	Honoring audit services and contributing to the dynamism and effectiveness of the audit profession			
Consequences of enclosing the characteristics of Machiavellianism				
Cultural and social consequences on the auditing profession	Clearing the ambiguity regarding the malpractice of companies	0.501	0.073	0.544
	Growth, excellence and dynamism of the profession			
	Accomplishing auditors' operational responsibility			
	Increasing audit quality and effectiveness of the profession			
	Ensuring the achievement of auditors' social goals			
	A more accurate basis for judgment and comment is created in outer space.			
	The amount of important mistakes (distortions) is minimized.			
A platform for increasing audit quality	The quality of information is improved in the decision-making process	0.536	0.072	0.509
	Fair distribution of income and quality results of financial reports			
	The usefulness of information increases			
	Qualitative features of information: reliability, comparability and relevance are improved			
	Restrictions on the sale of opinions and creating public confidence are achieved.			
	Capital market efficiency and optimal allocation of resources			
	Reducing information risk and increasing the reliability crediting and assurance of auditors			
	Preventing the outsourcing of auditors' work to third parties			
	Reducing coercive financial corruption			
	Increasing the quality of financial reporting			

The results of divergent validity are shown in Table 6. Fornell and Larcker's (1981) method was used for the divergent validity test. The relationship of each component with its identifiers and with other components has been investigated in this test. The values of the correlation coefficient between the components in the primary diameter and the square root of the extracted average variance values for each component are presented in the table below. As can be seen, the model's components interact more with each other than the corresponding components, confirming the model's divergence.

Also, the results of measuring the model's reliability, i.e., Cronbach's alpha and composite reliability, were 0.711 and 0.796, respectively, which shows that the fitted model has good reliability. The coefficients of each path and the significant values of each path indicate the explanatory power of each component. Path coefficients between hidden components show the explanatory power of the presented structural model.

Table 6. Fornell and Larcker matrix results

Components	Cultural, environmental and social	Structural and technical factor	Financial and economic factor	Perceptual, technical and knowledge factors	Legal and regulatory factor	Cultural and social background	Structural and technical reforms	Economic improvement and political connections	Strengthening the knowledge and skills of human resource	Providing a legal and regulatory platform	Cultural and social consequences	A platform for increasing audit quality
Cultural, environmental and social	0.657											
Structural and technical factors	0.052	0.667										
Financial and economic factors	0.631	0.427	0.767									
Perceptual, technical and knowledge factors	0.671	0.105	0.031	0.769								
Legal and regulatory factors	0.292	0.189	0.023	-0.107	0.739							
Cultural and social background	0.353	0.120	0.218	0.157	0.180	0.742						
Structural and technical reforms	0.650	-0.241	-0.269	0.411	-0.007	0.180	0.721					
Economic improvement and political connections	0.440	-0.026	0.055	0.219	-0.047	-0.007	0.339	1.000				
Strengthening the knowledge and skills of human resources	0.508	0.058	-0.016	0.205	0.068	-0.047	0.206	0.350	0.694			
Providing a legal and regulatory platform	0.040	-0.052	-0.014	-0.120	0.309	0.068	-0.024	0.260	0.335	0.701		
Cultural and social consequences	0.249	-0.003	0.013	0.048	0.374	0.309	0.050	-0.127	0.023	0.178	1.000	
A platform for increasing audit quality	0.666	-0.234	-0.228	0.228	0.423	0.374	0.275	0.069	-0.174	0.057	0.217	1.000

4.1 Summarizing and developing the structural model

The structural model of the research shows the impact of each factor that creates a gap between the expectations of auditors and users of financial reports. The results of the path analysis of the leading research components are shown in Figure 1. As can be seen, cultural, environmental, and social factors amount to (0.276); structural and technical factors (0.270); financial and economic factors (0.394); cognitive, human, and knowledge factors (0.597); inhibitory and supervisory factors (0.658) are effective in creating the Machiavellian bias of auditors. Also providing cultural and social services to the extent of (0.601); structural and technical reforms (0.468); economic improvement and political communication (0.514); strengthening the knowledge and skills of human resources (0.521) and providing a legal and regulatory framework (0.492) were counted among the strategies to contain Machiavellian tendencies. Finally, the cultural and social consequences on the auditing profession (0.530) and creating a platform for increasing Audit quality (0.522) were explained in line with the consequences of enclosing Machiavellian distortions. Figure 1 shows the structural model of the research.

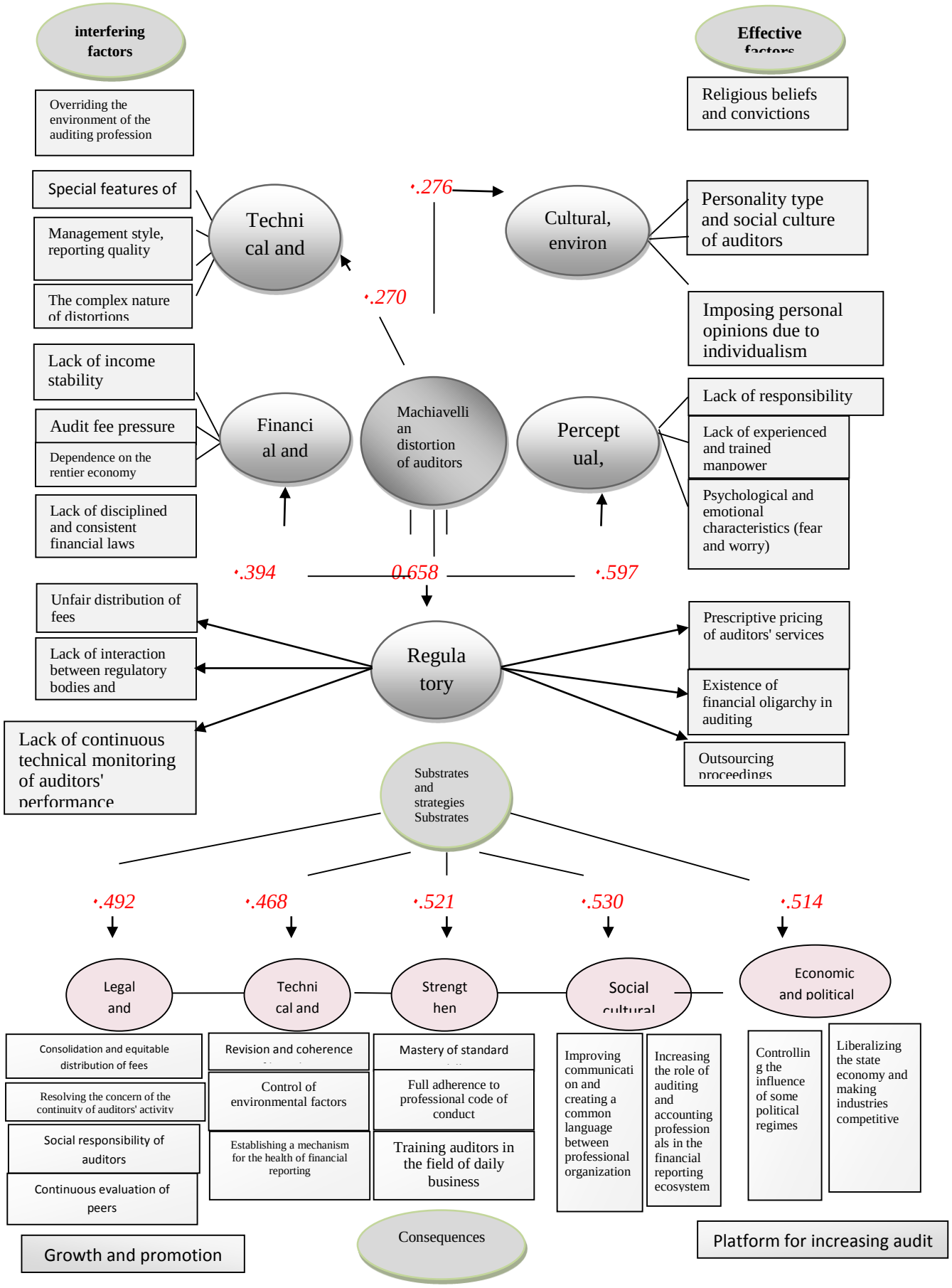
interfering factors
Overriding the environment of the auditing profession
Special features of
Management style, reporting quality
The complex nature of distortions
Techni cal and
Lack of income stability
Audit fee pressure
Dependence on the rentier economy
Lack of disciplined and consistent financial laws
Financi al and
Effective factors
Religious beliefs and convictions
.276
Cultural, environ
Personality type and social culture of auditors
.270
Imposing personal opinions due to individualism
Machiavelli an distortion of auditors
Lack of responsibility
Lack of experienced and trained manpower
Psychological and emotional characteristics (fear and worry)
Percept ual,
.394
0.658
.597
Unfair distribution of fees
Lack of interaction between regulatory bodies and
Lack of continuous technical monitoring of auditors' performance
Regula tory
Prescriptive pricing of auditors' services
Existence of financial oligarchy in auditing
Outsourcing proceedings
Substrates and strategies Substrates
.492
.468
.521
.530
.514
Legal and
Techni cal and
Strengt hen
Social cultural
Economic and political
Consolidation and equitable distribution of fees
Resolving the concern of the continuity of auditors' activity
Social responsibility of auditors
Continuous evaluation of peers
Revision and coherence
Control of environmental factors
Establishing a mechanism for the health of financial reporting
Mastery of standard
Full adherence to professional code of conduct
Training auditors in the field of daily business
Improving communicati on and creating a common language between professional organization
Increasing the role of auditing and accounting profession als in the financial reporting ecosystem
Controllin g the influence of some political regimes
Liberalizing the state economy and making industries competitive
Growth and promotion
Consequences
Platform for increasing audit

Figure 1. Encapsulation pattern of Machiavellian Views of auditors

In Table 7, the results of the path analysis show the explanatory power of each of the components affecting the Machiavellian tendencies of auditors and the platforms and strategies for enclosing Machiavellian tendencies.

Table 7. Path analysis results of research components

Path	P-value	Path coefficients
Cultural, environmental and social factors	0.276	<0.012
Structural and technical factors	0.270	<0.003
Financial and economic factors	0.394	<0.001
Perceptual, human and scientific factors	0.597	<0.001
Preventive and regulatory factors	0.658	<0.001
Providing a cultural and social platform	0601	<0.001
Structural and technical reforms	0.468	<0.010
Economic improvement and political connections	0.514	<0.002
Strengthening the knowledge and skills of human resources	0.521	<0.008
Providing a legal and regulatory platform	0.492	<0.020
Cultural and social implications on the auditing profession	0.530	<0.001
A platform for increasing audit quality	0.522	<0.003

5. Discussion and conclusion

Auditing the knowledge of doubt is the pursuit and collection of evidence, the methods of which are based on historical facts. Financial statements mainly reflect the financial effects of past events and do not include non-financial performance measures or prospects and plans. Credibility and legitimacy as the cornerstone of the auditing profession result from the capacity of this profession to respond to the responsibilities arising from their professional judgments. The need to instil auditors' responsibilities through their ethical judgments is created. The present study tried to provide strategies to increase audit quality by identifying the Machiavellian tendencies of auditors in significant judgments and calculating the consequences of moral values in limiting their behavioral patterns. Therefore, this study provides critical practical consequences for auditors, supervisory institutions, professional associations, and researchers, showing that paying attention to these strategies can help improve the quality of auditors' judgments.

In this regard, in the first phase of the research, the main factors affecting the creation of Machiavellian tendencies of auditors, the bases and strategies to contain them, and the consequences of preventing auditors' behavioral strains were calculated through 14 semi-structured interviews among the experts of the auditing profession in Iran at the academic and executive levels. In the second phase, 162 questionnaires were compiled and distributed based on the concepts extracted from the interviews, of which 154 items were evaluated as measurable. This section was implemented to determine the impact of each of the existing and emerging components between the interviewed members and professionals in the auditing profession. The effect of each factor that creates the Machiavellianism of auditors and its confinement strategies, along with the consequences of each, were analyzed using one of the multi-indicator decision-making techniques, structural equations, and PLS software. The results showed that cultural, environmental, and social factors; structural and technical factors; financial and economic factors; cognitive, human, and knowledge factors; and preventive and supervisory factors have amounted to and effectively created Machiavellian distortions of auditors. Also providing cultural and social services; structural and technical reforms;

economic improvement and political communication; Strengthening the knowledge and skills of human resources and providing a legal and regulatory framework effective in providing strategies to contain Machiavellian tendencies, and finally, cultural and social consequences on the auditing profession and foundation To increase audit quality is one of the consequences of enclosing Machiavellian distortions. The findings of this research are based on the studies of Mansouri Nalbandan and Hashemi Gohar (2021) and Sayal and Singh (2020).

In line with the main research question, the results showed that the auditors' lack of real understanding of the economic consequences of conservative reporting has created a gap between the expectations of financial report users and auditors. The current research evidence indicates that the auditors act more boldly and rigorously at the end of their tenure in the unit under review than in the first two years. In other words, internal independence becomes more apparent in the last year of the auditors' tenure. Also, auditors' judgments are based on something other than mastery of judgment concepts and tools, and the misappropriation of critical judgments has caused their unfavorable performance. This issue may be caused by high work density and influential personal characteristics such as optimism or pessimism, emotions associated with stress and worry, inattention to social goals, personal pressure and intimidation, and incorrect application of standards due to weak training and insufficient skills. Of course, the environmental conditions and the specific characteristics of the auditing profession are also not without influence. Discrimination and the lack of meritocracy for exemplary work, the existence of a vague future of work, mental and economic conflicts, global developments, and the specialization of affairs were among the factors that are influential in creating the negative characteristics of auditors' Machiavellianism. Also, in line with how to limit the negative characteristics of auditors' Machiavellianism, the primary conditions and strategies that can be enumerated include equipping auditors with moral and value standards and equipping them with more investments in the field of today's business education, establishing communication and a common language between audit committees and independent and internal auditors (as the executive arm of audit committees), ranking auditors (each audit does not necessarily have permission to audit any company of any size, such as the engineering system organization); selection of auditors based on experience in a specific industry with specific rules and regulations; providing the necessary legal framework for the execution and implementation of judicial accounting and the rating of auditors and the evaluation of colleagues, all of the strategies to limit the negative characteristics of the Machiavellianism of auditors were explained.

Accounting and auditing are products of social relations and arise out of necessity. In our country, this profession is a product of political relations, and from the point of view of stakeholders and managers, auditing is mandatory, not necessary. Also, accounting and auditing standards have yet to be well adapted to the environmental conditions of the country and existing businesses, which has deepened the gap between businesses and the ability to implement standards. The standards developed in a competitive economy with up-to-date laws cannot be implemented in a non-transparent government economy. In addition to these factors, the need for sufficient monitoring of auditors' performance by professional associations and supervisory institutions regarding the auditors' critical judgments, which their Machiavellian tendencies and behavioral patterns have influenced, has also been shown to neglect their social responsibilities. In general, our country needs a comprehensive definition of a responsible auditor. Also, the lack of specialized and trained personnel, the second-hand nature of the work, the breaking of the fee rate, and, most importantly, the non-compliance with the code of professional conduct have been influential in the unfavorable performance of auditors. Conducting audits and judgments combined with Machiavellian tendencies will not only help information transparency in complex businesses, but it will also lead to non-optimal allocation of resources in financial markets and incorrect decisions. In this situation, the attraction of foreign

investment is reduced due to the lack of a transparent capital market, and fraud, collusion, and misuse of assets also increase. Also, auditors' independence faces more uncertainty, and political thinking and mismanagement in the country's economic environment are becoming more visible. Deviation of facility consumption, unbridled money laundering, non-productive and ineffective investments, inefficient human resource recruitment, and delayed reporting are all consequences of judgments based on Machiavellian characteristics.

It is suggested to strengthen auditors' perception, continuous training in using standard skills and new tools, and full compliance with the code of professional conduct. Auditors should be equipped with excellent professional ethics and professional associations to invest more in education. Complete adherence to the professional code of conduct through maintaining internal independence, using expert human resources, and preventing the outsourcing of the proceedings process can effectively make the auditing profession market competitive through the quality of work. The interaction between professional organizations in the continuous monitoring of audit quality, the obligation to fully adhere to the code of professional conduct, joint efforts, and the coherence of laws, regulations, and standards in controlling auditors' behavioral patterns are among the things that are essential steps in increasing audit quality by limiting the Machiavellian biases of auditors. The findings of this research, with the studies of Wijayanti (2018), Pranyanita and Sujana (2019), Murphy (2012), Putu et al. (2020), Cahyono and Sudaryati (2023), Prativi (2021), was in agreement with the findings of Tricky et al. (2017), Pesudo et al. (2023), Mujiono and Jonnardi (2022) and Putu et al. (2020).

5.1 Practical implications

To limit the distortions of Machiavellianism, the solutions to curb it and its effect on the quality of audit judgments are suggested as follows. Awareness of the results of the negative characteristics of Machiavellianism in auditors and its impact on the quality of their important judgments is well known. Also, restructuring the composition of audit partners and using social science and information technology specialists in the composition of audit institutes' partners, or even, if possible, joint working groups to improve the quality of auditing, will help to improve the quality of auditors' judgments and prevent their behavioral abuses. The community of certified accountants should provide a platform so that the monopoly in referring to audit work is minimized and the audit market becomes competitive due to the quality of work.

Auditors should equip themselves with professional ethics within the framework of compliance with the code of professional conduct, and auditing institutions should pay special attention to more investments in education. Also, it is undeniable that auditors are in the vicinity of risk and produce risk by submitting an audit report. Auditors should benefit from civil liability insurance for this purpose. Finally, it is suggested to provide a platform for stakeholders to report auditors' violations to the competent authorities through a free reference.

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IJAAF; Vol. 9, No. 2, Spring 2025, Serial 31

Iranian Journal of
Accounting, Auditing & Finance

Ferdowsi University of Mashhad

Quarterly

RESEARCH ARTICLE

The Effect of The Common Auditor in Supply Chain on Corporate Tax Avoidance

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How to cite this article:
Rahrovi Dastjerdi, A. and Sohrabiani, H. (2025). The Effect of The Common Auditor in Supply Chain on Corporate Tax Avoidance. Iranian Journal of Accounting, Auditing and Finance, 9(2), 157-174. doi: 10.22067/ijaaf.2025.45866.1488
https://ijaaf.um.ac.ir/article_45866.html

ARTICLE INFO

Article History
Received: 2024-03-12
Accepted: 2024-09-30
Published online: 2025-04-15

Keywords:
Auditor's Expertise, Auditor's Economic Dependence, Common Auditor, Concentration in The Industry, Tax Avoidance

Abstract

A common auditor is when the same auditing firm audits a company and at least one of its major clients. The main objective of this article is to address the question of whether the presence of Common auditors has an impact on tax avoidance activities within a company. It also examines how auditor industry expertise, auditor economic dependence on the client, and industry concentration affect this relationship. Using a sample of 150 companies from 2013 to 2023 and testing hypotheses with OLS regression, the study found that common auditors within a supply chain increase tax avoidance. However, while auditor industry expertise does not affect this relationship, auditor economic dependence and industry concentration weaken the positive impact of common auditors on tax avoidance. These findings enhance the understanding of the complex relationship between common auditors and clients and offer valuable insights for policymakers, standard-setters, and professionals in auditing and taxation to address issues related to common auditors and tax avoidance more effectively.

https://doi.org/10.22067/ijaaf.2025.45866.1488

NUMBER OF REFERENCES
32

NUMBER OF FIGURES
1

NUMBER OF TABLES
6

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

Common auditors occur when two companies with business relationships share the same auditor (Hu et al., 2023). Different institutions' audit methodologies suggest that each approach similarly identifies errors across different entities. Therefore, the discrepancies in financial statements between companies audited by the same auditor are likely to be much smaller than those between companies audited by different auditors because different auditors use different styles in practice (Francis et al., 2014). On one hand, the style and context of auditing can be influenced by how accepted accounting principles are interpreted. On the other hand, each auditing institution has its own rules for interpreting and applying these principles, similar to how they apply auditing standards from the same sources. Based on this, it is believed that companies with the same auditors tend to experience similar audit methods. This phenomenon is known as the "common auditors effect" (Chen, 2023). As a result, the procedures followed by auditing institutions lead to systematic differences in their auditing approaches and the interpretation and implementation of accounting standards (Kothari et al., 2010).

The presence of common auditors can lead to various consequences, including enhanced transparency and reduced information asymmetry, improving the readability and quality of information disclosure within a company's information environment (Almaharmeh et al., 2021), Increased comparability of accounting information (Chen et al., 2020), implementation of consistent and uniform internal controls (Chen, 2023), potential for tax avoidance within the supply chain (Hu et al., 2023) and possible impact on cost stickiness (Cai et al., 2019). Each of these factors can influence accounting profit in various ways. Exploring how common auditors impact accounting profit factors represents a unique study area. Given the theoretical gap in Iran's economic environment, considering it is a developing country, this research aims to address this issue. Specifically, this research examines the effect of the presence of common auditors in the supply chain on corporate tax avoidance.

Tax avoidance involves strategies to minimize the amount of taxes paid. In other words, it is the practice of exploiting legal loopholes in tax laws to reduce one's tax burden while still adhering to the letter of the law (Hanlon and Heitzman, 2010). The impact of common auditors on corporate tax avoidance is likely to stem from a reduction in "information asymmetry." Previous research indicates that having a common auditor lowers information asymmetry and enhances transaction efficiency (Hu et al., 2023). Supply chain research suggests that the role of auditors in providing information becomes more significant when both the supplier and the customer share the same auditor. This is because it reduces information asymmetry within the supply chain (Dhaliwal et al., 2017). A common auditor can foster financial coordination among firms by reducing informality in taxation. Specifically, common auditors, by leveraging both public and private information gathered during audits of suppliers and their customers, are well-positioned to build strong relationships and design tax strategies beneficial to both supplier and customer groups. Moreover, having a common auditor significantly enhances information sharing, reducing the marginal costs of tax administration across the supply chain (Hu et al., 2023).

This research can contribute in several ways and add valuable insights to the existing body of knowledge in this field. First, it offers solid empirical evidence on how common auditors affect companies' tax strategies within a supply chain. This insight can enhance our understanding of the influence of common auditors on corporate behavior and shed light on their broader impact on corporate governance mechanisms. Secondly, the findings of this study can guide policymakers and regulatory bodies in developing guidelines or regulations regarding auditor selection, audit practices, and auditor responsibilities. Specifically, if the results demonstrate a significant role of common auditors in the corporate tax avoidance process, they could serve as a foundation for practical

recommendations to reduce tax avoidance. This might involve improving the supervision of auditors' work and optimizing audit processes. Third, shareholders and other stakeholders can make more informed decisions regarding their investments and interactions with companies by understanding the potential impact of common auditors on tax strategies. Finally, this study contributes to the existing literature in accounting and auditing, particularly in auditing and taxation, and offers a foundation for future research.

Unlike Hu et al. (2022), which emphasizes industry expertise as a key contributor, this research uniquely finds that industry expertise does not significantly impact the auditor-tax avoidance relationship, thus expanding the discussion around boundary conditions for common auditor effects. Moreover, the results of this study align with the work of Bae et al. (2019), who examined auditor expertise in relation to audit pricing and suggested that economic conditions alter auditor efficiency and independence. This study further emphasizes how auditor economic dependence affects tax strategies, encouraging improvements in audit supervision and refining audit processes to counter tax avoidance.

2. Literature review and hypothesis development

2.1 The concept of the common auditor and its informational role

Common auditors occur when two companies with a business relationship use the same auditing firm. A segment of auditing literature explores the category of common auditors, focusing on the economic behavior of client companies that share auditors. Chen (2023) has divided the studies into two categories: The first category pertains to the auditor's style, a concept derived from the research of Francis et al. (2014); they define style as a distinctive set of specific policies and procedures used to standardize audit services (Kothari et al., 2010). This method is widely used in audit institutions, contributing to developing an auditor's personal style. In this category of literature, Francis et al. (2014) found that companies sharing the same auditors exhibit a higher comparability of financial statements in the United States. Jiu et al. (2020) observed a similar phenomenon in a Chinese sample. The second strand of literature focuses on the information-sharing role of common auditors. This is because auditors can easily gather substantial amounts of private client information through audit evidence collection, risk assessment, analytical procedures, substantive testing, and communication with management (Knechel et al., 2009). Therefore, there is a possibility that auditors may share this information with other clients. Previous research shows that auditors can provide valuable information in various contexts when serving different groups, including buyers and target companies (Cai et al., 2016); analysts and public companies (Fang et al., 2020); banks and borrowers (Francis and Wang, 2021); mutual funds and public companies (Hope et al., 2023); and suppliers and customers (Dhaliwal et al., 2017).

Accordingly, this research focuses on the second role of common auditors, that is, the special informational role of common auditors in a supply chain. In other words, when the supplier and its customer have a common auditor, there will be an information advantage due to access to accounting information and other information from both sides of the supply chain, which can facilitate tax avoidance.

2.2 The concept of Tax Avoidance and the mechanism of receiving impact from common auditors in the supply chain

One of the factors that can affect the accounting profit reported by the company is the corporate tax rate (Kovermann and Wendt, 2019). One stakeholder benefitting from company profits is the government, which participates through tax identification, recognition, and collection. In Iran, the

government imposes a fixed tax rate on legal entities, but not all company earnings are subject to tax or may be taxed at different rates. Additionally, some expenses listed in the profit and loss statement for accounting purposes may not be recognized as deductible expenses for tax purposes. Due to such differences, another tax rate is created in practice, which is known as the effective tax rate (Dhawan et al., 2020). Logically, managers always seek to reduce the effective tax rate by using different solutions and avoiding paying taxes. Regardless of whether this practice is ethical, the literature indicates that action towards tax avoidance is possible through applying accounting principles, rules and standards (same source). Therefore, it can be said that tax avoidance is an attempt to reduce the taxes paid. In other words, tax avoidance is a form of using loopholes in the tax laws to reduce the tax paid; in other words, it is considered a form of tax avoidance without significantly leaving the scope of the tax laws (Hanlon and Heitzman, 2010). At the same time, in Iran, neglecting the issue of taxes is one of the main obstacles to economic and social development, and today, non-compliance with tax regulations is one of the most important and challenging problems not only in Iran but in many developed countries (Darabi And Zamani, 2017). There are two perspectives on how common auditors utilize their informational advantage and its impact on the client's tax avoidance. According to the first view, a common auditor can thoroughly access and verify supply chain transactions between suppliers and customers. This perspective suggests that auditors also gain a deeper understanding of any special relationships within the supply chain, which can enhance the accuracy and effectiveness of the audit (Chen et al., 2012).

Therefore, access to such information enables the auditor to effectively assess the client's tax management strategy, reduce audit risk associated with corporate tax avoidance, and curb tax avoidance behavior. From this perspective, a common auditor can deter corporate tax avoidance. Conversely, the second perspective suggests that a common auditor might actively engage in the client's corporate tax avoidance activities. For example, to attract and retain clients, common auditors may be motivated to expand their professional knowledge and assist clients with tax strategies. In other words, the informal network created by the common auditor and the spillover effects of knowledge and trust created related to it will intensify tax avoidance in companies (Hu et al., 2023). According to this perspective, the common auditor directly impacts the company's tax avoidance. Audit literature supports the common auditor's positive and negative effects on tax avoidance. As a result, we do not propose a specific direction for this effect; instead, we will allow the data to reveal the direction. Therefore, the first hypothesis of the study is formulated as follows:

H1: Common auditors in the supply chain affect the company's tax avoidance.

2.3 The mechanism of the moderating effect of moderating variables on the relationship between common auditors and tax avoidance

Other moderating factors might affect the impact of having a common auditor on a client's tax avoidance. Our audit literature review identified three variables that could influence this effect. These three variables are explained below:

2.3.1 Auditor expertise in the industry

Auditors with industry expertise gain in-depth knowledge through their audit work, enhancing their ability to understand clients' business and financial risks. This expertise enables them to identify tax issues, opportunities, and risks related to tax management, often the foundation of tax planning. Previous research indicates that industry-expertise auditors can help clients with tax avoidance strategies (McGuire et al., 2012; Wei, 2014). Since industry expert auditors analyze and review many companies in a particular industry, they have more experience than other auditors, and hence their competence to detect significant distortions and biases in the disclosed information of clients is higher

than others (Lari Dasht Bayaz and Hassanpour, 2019).

Auditors with industry expertise also bring an enhanced ability to assess intercompany transactions and financial arrangements within specific industries. This deeper understanding equips them to discern aggressive tax practices that may emerge due to industry-specific dynamics, such as transfer pricing strategies or exploiting tax loopholes tailored to certain business models. Their specialized knowledge further aids in scrutinizing tax shelters or deferred tax assets unique to particular industries, allowing them to accurately identify and assess tax avoidance schemes. When upstream and downstream companies in a supply chain share a common auditor with industry expertise, this auditor is better equipped to understand the detailed operations between them. The industry-expert auditor can gain insights into transactions such as back-and-forth exchanges and post-sale repurchases and identify risks in activities between suppliers and their customers.

Additionally, the auditor's deep understanding of regulatory frameworks and tax codes specific to the industry enhances their ability to suggest proactive tax planning strategies. They can assist in structuring transactions to minimize tax liabilities while remaining compliant with tax laws. This becomes particularly relevant when companies in the same industry face similar regulatory challenges or opportunities, allowing common auditors to leverage this knowledge across multiple. The ability to navigate complex industry-specific tax codes further empowers these auditors to tailor tax strategies, thus moderating the relationship between the common auditor and tax avoidance. By leveraging their firm's accounting and tax expertise, common auditors can enhance their clients' tax activities by identifying opportunities for tax optimization and implementing effective tax strategies. Additionally, offering audit and tax advisory services to clients within the supply chain allows common auditors to expand their client base and increase revenue at a relatively low cost. This growth potential provides strong incentives for common auditors to apply their financial and tax expertise to assist clients with tax management (Hu et al., 2023).

Therefore, the level of industry expertise possessed by auditors of companies within a supply chain may influence the extent to which these auditors engage in tax avoidance strategies for their clients. Based on this, the second hypothesis of the research is formulated as follows:

H2: Expertise of the auditor in the industry moderates the effect of common auditor on tax avoidance.

2.3.2 Auditor's economic dependence on the client

The purpose of an independent audit is to enhance the credibility of the owners' accounting information, making the auditor's independence and impartiality crucial. In this context, independence is a mindset that ensures the auditor's opinions and conclusions remain unaffected by the pressures arising from conflicts of interest (Mautz and Sharaf, 1961). One of the issues that can endanger the auditor's independence is economic dependence on a client or a group of clients. Previous research on the effects of auditors' economic dependence on clients on audit quality has shown different results (Geiger and Blay, 2013; Chi et al., 2012; Hossain et al., 2016).

When an auditor economically depends on a client or clients within the same supply chain, the potential threat to the auditor's independence is heightened. This dependency creates a situation where the auditor may prioritize maintaining favorable relationships over exercising objective judgment. Suppose an auditor is concerned that a dispute with one client could jeopardize future engagements with another client in the same supply chain. In that case, they may be inclined to compromise their professional integrity to secure ongoing fees. Such economic ties can undermine the auditor’s independence and potentially diminish the quality of the audit.

When an auditor is responsible for auditing a company and its customers within the same supply

chain, self-interest threatens the auditor's independence. The auditor might worry that a conflict with the management of one client could jeopardize future fee income from another client in the supply chain. Such economic ties can undermine the auditor's independence and potentially diminish the quality of the audit. Consequently, high levels of economic dependence on having a common auditor across the supply chain may result in reduced professional skepticism or an increased likelihood of the auditor succumbing to management pressure during disputes. This is particularly concerning when economic ties create an environment where auditors may prioritize client retention over ethical obligations. Research indicates that auditors facing significant economic dependence exhibit a reduction in their ability to challenge aggressive accounting practices or tax strategies proposed by management, ultimately leading to a higher probability of implementing tax avoidance strategies without adequate scrutiny. Auditors may give in to client pressure by restricting tax practices (Hu et al., 2023).

Furthermore, this situation may worsen when auditors offer non-audit services, such as tax advice, to their clients within the supply chain. As a result, the economic dependence of auditors on companies in the supply chain could either strengthen or weaken these companies' actions regarding tax avoidance strategies. Based on this, the third hypothesis of the research is formulated as follows:

H3: The economic dependence of the auditor on the client moderates the effect of the common auditor on tax avoidance.

2.3.3 The degree of concentration in the industry

Industry concentration affects a firm's bargaining power within the supply chain. For instance, if a business contract is terminated, it becomes more expensive for the customer to find a replacement supplier when the original supplier is in a concentrated and less competitive industry. In other words, a vendor operating in a more concentrated industry has greater bargaining power with its customers. Additionally, industry concentration often signals greater stability in the supply chain. Companies are more likely to maintain stable business relationships with their supply chain partners when an industry is highly concentrated. A stable supply chain relationship enables effective cooperation and information sharing among partners, which can help companies identify tax avoidance opportunities more effectively (Cen et al., 2017).

A stable supply chain relationship enables effective cooperation and information sharing among partners, which can help companies identify tax avoidance opportunities more effectively. This information sharing is crucial, as research shows that firms in concentrated industries often collaborate to optimize tax strategies, leveraging shared insights and experiences. Conversely, when the supply chain relationship is unstable, companies are less inclined to share tax-related information and are generally less motivated to seek assistance from other parties in tax planning. In such environments, the lack of trust and collaboration diminishes the potential for effective tax avoidance strategies.

When the supply chain relationship is unstable, companies are less inclined to share tax-related information and are generally less motivated to seek assistance from other parties in tax planning. From the perspective of common auditors, when the concentration in the supplier firm's industry is high, the supplier firm has more bargaining power and can obtain supply chain information directly from its partners. In this case, supply chain companies have a limited need for common auditor information, and the role of the common auditor is reduced. On the other hand, when a supplier firm's industry concentration is low, it has less bargaining power and is less likely to share information with its supply chain partners. In such cases, the firm has a greater incentive to consult with a common auditor for tax-related supply chain information and to rely on the auditor to assist with tax avoidance strategies (Hu et al., 2023).

In summary, a lower industry concentration within a supply chain enhances common auditors' informational and mediating role in assisting companies (suppliers and their customers) with tax avoidance. Thus, the effectiveness of common auditors in supporting tax avoidance programs can vary depending on the level of industry concentration within the supply chain. Consequently, the fourth hypothesis of the research is formulated as follows:

H4*:* The degree of industry concentration moderates the effect of a common auditor on tax avoidance.

Figure (1) illustrates the mechanism by which common auditors impact tax avoidance, incorporating three moderating factors.

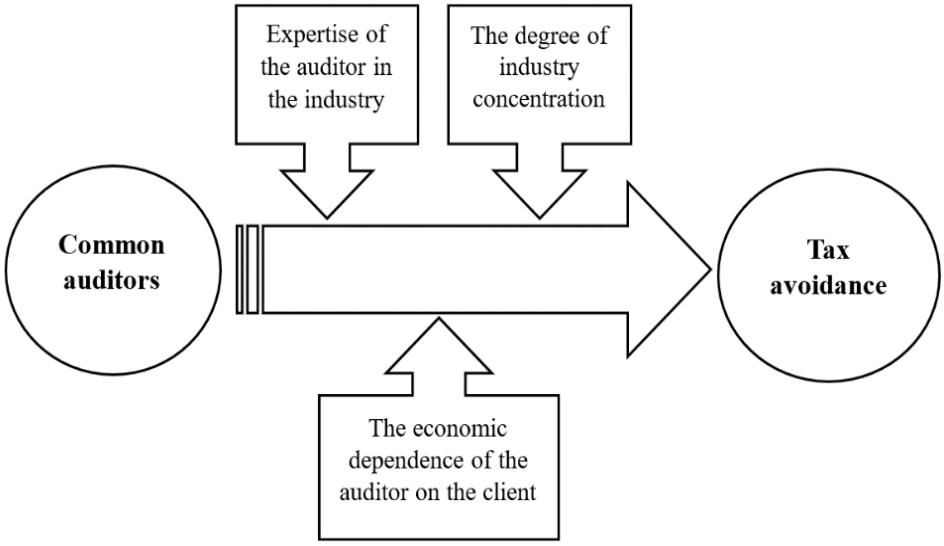

Figure 1. The relationship among research variables

3. Research methodology

This study is a post-event, descriptive-correlation research. Data needed for the research models were sourced from the Rahavard Novin database, and the explanatory notes in the published financial statements are available on the Codal website. Using a screening method, the research sample was drawn from active companies listed on the Tehran Stock Exchange between 2013 and 2023. Companies were selected for the sample based on meeting the following three criteria simultaneously:

a) They should not be among the financial intermediaries, banks, insurance companies, or leasing companies. b) Their fiscal year ends at the end of March. c) All necessary information for calculating variables and implementing research models for that company is available. Based on these conditions, 150 companies were selected as research samples.

3.1 Research variables

The ***independent variable*** in this study is the presence of a common auditor within the supply chain (COMAUD). To determine this variable, we followed the method outlined by Dhaliwal et al. (2017) and Hu et al. (2023). This involved reviewing the company's accounts receivable notes to identify the company's customers. Next, by examining the information on these customers, we determined which of them share a common auditor with the company. For instance, if the company's third or fifth customer has the same auditor, the values 3 and 5 are assigned to this variable, respectively. If none of the company's customers share an auditor with the company, the variable is

assigned a value of zero.

The ***dependent variable*** in this research is corporate tax avoidance. Two methods were employed to calculate this variable to enhance the robustness of the results. The first method, based on the approach of Henry and Sansing (2018) and Hu et al. (2023), calculates the tax avoidance variable (DELTA) as follows:

$$\textbf{DELTA} = \frac{(Taxable\ Profit \times Tax\ Rate - Taxes\ Paid\ This\ Year - Taxes\ Paid\ Last\ Year)}{(Book\ Value\ of\ Assets + Market\ Value\ of\ Capital - Book\ Value\ of\ Capital)}$$

In the second method, following Crabtree and Kubik (2014), the tax avoidance variable *(ETR)* is calculated as tax paid divided by taxable profit.

Also, in this research, three moderating variables have been used, which are:

Auditor expertise in the industry (AUDSPEC): This is calculated by dividing the total assets of companies audited by a firm within a specific industry by the total assets of all companies audited by that firm across the entire sample. For each auditor, the industry with the highest value is assigned a value of one, while all other industries for that auditor are assigned a zero value (Hu et al., 2023).

Economic dependence of the auditor on the client (ECONDEPEND): This variable is calculated by dividing the assets of each company audited by an auditor by the total assets of all companies audited by that auditor within the sample. If this ratio exceeds the median value for the entire sample, it is assigned a value of one; otherwise, it is assigned a value of zero (Hu et al., 2023).

Concentration in Industry (HHI): This is measured using the Herfindahl-Hirschman Index (HHI), which is the sum of the squares of the market share percentages of each company within the industry (Hu et al., 2023).

Also, following Bradshaw et al. (2019) and Hu et al. (2023) and to control the effects of other variables affecting tax avoidance, the following control variables have been used in the research models:

Return on assets *(ROA):* the ratio of net profit to total assets; Leverage *(LEV):* the ratio of total liabilities to total assets; Company size *(SIZE):* the logarithm of the sum of total assets; Company growth rate *(GROWTH):* Change in current year's sales minus previous year's sales divided by previous year's sales; Fixed assets *(PPE):* the ratio of property, machinery and equipment to total assets; Intangible assets *(INT):* ratio of intangible assets to total assets; Auditor quality *(BIG4):* if the company's auditor is an audit organization, the value is one and otherwise, the value is zero; The auditor's opinion type *(OPINION):* If the opinion is acceptable, the value is one and otherwise, the value is zero.

4. Findings

4.1 Descriptive statistics and correlation analysis of research variables

Table 1 summarizes the key descriptive statistics for this research, while Table 2 displays the Pearson correlation coefficients among the variables.

Table 1. Descriptive statistics of research variables

Variables	Mean	Median	Maximum	Minimum	Standard Deviation	Observations
DELTA	0.030	0.018	0.243	-0.111	0.050	1214
ETR	0.121	0.084	0.616	0.000	0.113	1152
COMAUD	1.478	1.000	5.000	0.000	1.004	1500
AUDSPEC	0.394	0.000	1.000	0.000	0.488	1500
ECONDEPEND	0.498	0.000	1.000	0.000	0.500	1500
HHI	0.279	0.244	0.823	0.070	0.156	1348
BIG4	0.190	0.000	1.000	0.000	0.392	1500
OPINION	0.534	1.000	1.000	0.000	0.499	1500
ROA	0.145	0.122	0.454	-0.045	0.118	1350
LEV	0.547	0.548	0.871	0.177	0.171	1350
SIZE	6.418	6.327	7.954	5.370	0.583	1350
GROWTH	0.366	0.296	1.940	-0.383	0.444	1213
PPE	0.248	0.219	0.618	0.035	0.149	1350
INT	0.353	0.178	2.005	0.000	0.440	1343

As it is clear in the table above, considering the closeness of the median and mean, it can be concluded that the variables of this research have a suitable statistical distribution. The average DELTA is equal to 0.030; this number shows that the profit before tax of companies is more than their taxable profit, and on the other hand, its minimum has also become negative (-0.111), which shows that In some companies, the accounting profit is lower than the taxable profit. The minimum ETR was zero, which indicates that some companies have not paid taxes even though they have made a profit. Also, 1,500 examined samples, with an average of 1,478, have shared auditors with at least one of their clients (Mean COMAUD=1.478). So, in some research samples, this sharing was with the first major customer, in some with the fifth customer, and in some cases, there was no sharing.

Furthermore, comparing our descriptive statistics with existing literature shows that our average tax avoidance rates align well with findings in emerging economy studies, where financial pressures, such as those in Iran, often encourage firms to pursue tax-saving strategies. Studies in Iran, for instance, reveal that tax avoidance averages tend to vary with the intensity of financial constraints and sanctions, resulting in higher mean tax avoidance levels than in more stable economies. Additionally, research demonstrates a positive association between common auditors and tax avoidance across various regions. For example, South Korea and Taiwan studies suggest that firms with extended auditor tenures or common audit firm relationships tend to show a greater propensity for tax avoidance as familiarity and dependency increase. Similarly, our findings align with the literature indicating that auditor independence can be compromised under conditions of high economic dependency, leading to greater tax avoidance due to reduced oversight. Research in Iran and Taiwan has found that high economic dependency can weaken auditors' resistance to aggressive tax strategies, as reflected in our results.

4.2 Hypothesis testing

We employed the combined data method with year and industry fixed effects to run all regression models. To address issues related to heteroscedasticity, we applied the Generalized Least Squares (GLS) method with cross-sectional weights. To account for autocorrelation, we used White's correction factor. Additionally, we utilized the Variance Inflation Factor (VIF) to mitigate the impact of multicollinearity among explanatory variables.

To test the first research hypothesis, we will implement Model (1) as follows:

Table 2. Pearson correlation coefficient between research variables

Variables	DELTA	ETR	COMAUD	AUDSPEC	ECONDEPEND	HHI	BIG4	OPINION	ROA	LEV	SIZE	GROWTH	PPE	INT
DELTA	1													
ETR	0.037	1												
COMAUD	0.053	0.355	1											
AUDSPEC	0.012	0.194	0.180	1										
ECONDEPEND	-0.086	0.097	-0.084	0.637	1									
HHI	-0.047	0.046	0.321	0.405	0.423	1								
BIG4	-0.100	0.113	-0.049	0.024	0.076	0.119	1							
OPINION	0.087	-0.044	0.154	0.078	0.083	-0.028	-0.430	1						
ROA	0.065	-0.477	-0.156	-0.339	-0.344	-0.283	-0.453	0.180	1					
LEV	-0.192	0.021	-0.219	-0.058	0.112	0.004	0.273	-0.062	-0.373	1				
SIZE	0.113	-0.145	-0.119	0.144	0.215	0.045	-0.282	0.096	0.305	-0.159	1			
GROWTH	-0.295	-0.233	-0.091	0.026	0.140	0.150	-0.026	0.155	0.160	0.071	0.160	1		
PPE	0.071	0.278	0.342	0.317	0.085	0.288	-0.108	0.072	-0.172	-0.524	0.077	-0.042	1	
INT	0.250	-0.001	0.045	0.110	0.086	0.276	-0.010	-0.017	-0.065	-0.219	0.010	-0.154	0.117	1

$$DELAT_iTaxAvoid_{i,t} = \alpha + \beta_1.COMAUD_{i,t} + \beta_2.ROA_{i,t} + \beta_3.LEV_{i,t} + \beta_4.SIZE_{i,t} + \beta_5.GROWTH_{i,t} + \beta_6.PPE_{i,t} + \beta7.INT_{i,t} + \beta_8.BIG4_{i,t} + \beta_9.OPINION_{i,t} + INDYSTRY_{i,t} + YEAR_i + \varepsilon_{i,t} \quad (1)$$

The first hypothesis is not rejected if the β1 coefficient is significant at the 95% confidence level. Table (3) shows the results of running Model (1) with two dependent variables (DELTA and ETR):

Table (3) shows that the COMAUD variable coefficient is positive in both cases and significant at the 95% confidence level. That is, the first hypothesis is confirmed. Of the two supporting views presented for the first hypothesis, the second view has been confirmed in this research. Common auditors actively participate in the client's tax avoidance activities. This participation may be motivated by several factors. *Attracting and Retaining Clients:* By offering advanced tax avoidance strategies, common auditors can draw in clients seeking to minimize their tax liabilities. *Building Long-Term Relationships:* With deep insights into the role of common auditors, firms can strengthen long-term client relationships and increase opportunities for additional work. Additionally, reducing clients' tax burdens through the services of common auditors can enhance customer satisfaction and foster loyalty. *Generating Income:* Services like tax planning and consulting are highly profitable. common auditors who develop expertise in these areas while conducting audits can enhance their revenue and financial stability by offering these valuable services. *Gaining a Competitive Advantage:* By providing tax avoidance strategies, auditors can distinguish themselves from competitors, thereby boosting their reputation and market position.

In summary, these incentives align auditors' financial and professional interests with companies' goals to minimize taxes, ultimately facilitating or intensifying clients' tax avoidance activities.

To test the second hypothesis of the research, Model (2) will be implemented as follows:

Table 3. The results of the first hypothesis test

DELTA						ETR					
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**VIF**	**Variable**	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**VIF**
α	-0.013	0.042	-0.300	0.765		α	0.121	0.161	0.748	0.456	
COMAUD	0.004	0.002	2.174	0.031	1.462	COMAUD	0.026	0.006	4.247	0.000	0.000
ROA	0.018	0.034	0.524	0.601	2.278	ROA	-0.318	0.122	-2.615	0.011	0.011
LEV	-0.083	0.025	-3.367	0.001	2.343	LEV	0.074	0.087	0.853	0.396	0.396
SIZE	0.017	0.006	3.140	0.002	1.474	SIZE	0.018	0.022	0.797	0.428	0.428
GROWTH	-0.030	0.007	-4.148	0.000	1.262	GROWTH	-0.065	0.020	-3.260	0.002	0.002
PPE	-0.069	0.020	-3.511	0.001	2.044	PPE	-0.015	0.127	-0.121	0.904	0.904
INT	0.016	0.010	1.486	0.139	1.188	INT	-0.026	0.047	-0.559	0.577	0.577
BIG4	-0.002	0.007	-0.303	0.763	1.445	BIG4	-0.041	0.029	-1.426	0.157	0.157
OPINION	0.002	0.006	0.322	0.748	1.456	OPINION	0.006	0.020	0.279	0.781	0.781
Adjusted R2	0.341	F-statistic	8.918	Prob F	0.000	Adjusted R2	0.669	F-statistic	18.064	Prob F	0.000
Year Effects		Controlled				Year Effects		Controlled			
Industry Effects		Controlled				Industry Effects		Controlled			

$$\textbf{DELAT}\quad TaxAvoid_{i,t} = \alpha + \beta_1.COMAUD_{i,t} + \beta_2.AUDSPEC + \beta_3.COMAUD\times AUDSPEC + \beta_4.ROA_{i,t} + \beta_5.LEV_{i,t} + \beta_6.SIZE_{i,t} + \beta_7.GROWTH_{i,t} + \beta_8.PPE_{i,t} + \beta 9.INT_{i,t} + \beta_{10}.BIG4_{i,t} + \beta_{11}.OPINION_{i,t} + INDYSTRY_{i,t} + YEAR_i + \varepsilon_{i,t} \quad (2)$$

The first hypothesis is not rejected if the β3 coefficient is significant at the 95% confidence level. Table (4) shows the results of running Model (2) with two dependent variables (DELTA and ETR):

Table (3) shows that in both cases, the auditor's expertise in the industry does not have a significant effect on corporate tax avoidance, nor is it able to moderate the effect of the common auditor on tax avoidance (The coefficient COMMAND*AUDSPEC variable coefficient is not significant in any of the two cases). These results show that the second hypothesis of the research has been rejected. Also, these results are not consistent with the theoretical logic of the research. In other words, the findings obtained in the present hypothesis test show an interesting contrast in which common auditors positively affect tax avoidance. Still, the auditor's industry expertise does not moderate this relationship. This result can be analyzed from several perspectives. *Building Networking Relationships Between Common Auditors and Clients:* Auditors working with companies within the same industry often develop a deep understanding of industry norms, practices, and strategies, including tax avoidance techniques. The influence on corporate tax avoidance may stem from sharing best practices and sophisticated strategies among clients, driven more by these network effects than by the auditor's individual industry expertise. *Standardization of Tax Avoidance Methods:* Some tax avoidance strategies are generic and applicable across various industries. For instance, techniques

such as transfer pricing and tax shelters are areas where auditors may possess broad expertise, diminishing the need for industry-specific knowledge. Tax laws tend to be more uniform across industries, reducing the emphasis on specialized industry expertise. *Internal Ability of Companies in Tax Planning:* Many companies hire tax consultants and experts specialized in their respective fields. These experts are typically better equipped to implement industry-specific tax strategies. Consequently, the role of the common auditor may be more focused on verifying these strategies rather than directly influencing them. *Ethical Considerations for Auditors:* Auditors are bound by ethical standards such as independence and impartiality in their assurance services. While they may offer tax planning advice during audits, these ethical principles can limit their active role in tax avoidance, regardless of their industry expertise.

Table 4. The results of the second hypothesis test

DELTA						ETR					
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**VIF**	**Variable**	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**VIF**
α	-0.063	0.047	-1.325	0.227		α	0.080	0.109	0.729	0.490	
COMAUD	0.006	0.002	2.455	0.044	2.495	COMAUD	0.027	0.006	4.469	0.003	2.211
AUDSPEC	-0.013	0.011	-1.205	0.267	3.344	AUDSPEC	-0.010	0.033	-0.316	0.761	3.298
COMAUD*AUDSPEC	-0.004	0.007	-0.468	0.654	4.439	COMAUD*AUDSPEC	-0.006	0.017	-0.339	0.744	4.432
ROA	-0.041	0.056	-0.727	0.491	2.606	ROA	-0.318	0.155	-2.056	0.079	3.404
LEV	0.004	0.040	0.102	0.922	2.945	LEV	0.088	0.071	1.241	0.254	3.822
SIZE	0.024	0.008	2.848	0.025	1.782	SIZE	0.023	0.021	1.108	0.304	1.971
GROWTH	-0.001	0.004	-0.309	0.767	1.649	GROWTH	-0.061	0.014	-4.348	0.003	2.087
PPE	0.002	0.050	0.030	0.977	2.502	PPE	0.028	0.138	0.205	0.843	3.304
INT	0.030	0.014	2.176	0.066	1.501	INT	-0.028	0.023	-1.200	0.269	1.101
BIG4	-0.032	0.009	-3.361	0.012	1.686	BIG4	-0.041	0.031	-1.318	0.229	1.622
OPINION	-0.014	0.007	-1.943	0.093	1.547	OPINION	0.006	0.021	0.263	0.800	1.579
Adjusted R2	0.404379	F-statistic	6.140391	Prob F	0.000	Adjusted R2	0.610474	F-statistic	12.3064	Prob F	0.000
Year Effects			Controlled			Year Effects			Controlled		
Industry Effects			Controlled			Industry Effects			Controlled		

In summary, the relationship between common auditors and tax avoidance is likely influenced more by the auditors' extensive network of relationships and the generalized nature of tax avoidance strategies than by their specific industry expertise. The broad network effects, the general applicability of tax avoidance methods, and the auditors' particular roles and limitations appear to play a more significant role than the auditors' deep knowledge of any industry.

To test the third hypothesis of the research, Model (3) will be implemented as follows:

$$DELAT_iTaxAvoid_{i,t} = \alpha + \beta_1.COMAUD_{i,t} + \beta_2.ECONDEPEND + \beta_3.COMAUD\times ECONDEPEND + \beta_4.ROA_{i,t} + \beta_5.LEV_{i,t} + \beta_6.SIZE_{i,t} + \beta_7.GROWTH_{i,t} + \beta_8.PPE_{i,t} + \beta 9.INT_{i,t} + \beta_{10}.BIG4_{i,t} + \beta_{11}.OPINION_{i,t} + INDUSTRY_{i,t} + YEAR_i + \varepsilon_{i,t} \quad (3)$$

The first hypothesis is not rejected if the β3 coefficient is significant at the 95% confidence level. Table (5) shows the results of running Model (3) with two dependent variables (DELTA and ETR):

Table 5. The results of the third hypothesis test

DELTA						ETR					
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**VIF**	**Variable**	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**VIF**
α	-0.003	0.034	-0.087	0.933		α	-0.064	0.086	-0.744	0.481	
COMAUD	0.013	0.011	1.187	0.274	2.8 65	COMAUD	0.041	0.009	4.464	0.003	2.6 46
ECONDEPEND	0.021	0.018	1.174	0.279	7.2 61	ECONDEPEND	0.063	0.025	2.535	0.039	5.0 42
COMAUD*ECONDEPEND	-0.032	0.013	-2.509	0.040	8.2 16	COMAUD*ECONDEPEND	-0.041	0.012	-3.350	0.012	5.5 46
ROA	-0.091	0.046	-1.989	0.087	2.6 17	ROA	-0.235	0.124	-1.887	0.101	3.5 79
LEV	-0.016	0.045	-0.347	0.739	2.8 63	LEV	0.158	0.059	2.677	0.032	4.1 84
SIZE	0.015	0.007	2.306	0.055	1.6 75	SIZE	0.026	0.019	1.362	0.216	2.0 90
GROWTH	-0.005	0.004	-1.317	0.229	1.7 59	GROWTH	-0.045	0.013	-3.367	0.012	2.2 25
PPE	0.018	0.057	0.317	0.761	2.6 50	PPE	0.041	0.109	0.374	0.720	3.3 81
INT	0.020	0.010	2.007	0.085	1.4 11	INT	-0.020	0.022	-0.928	0.384	1.1 47
BIG4	-0.037	0.009	-3.880	0.006	1.7 65	BIG4	-0.035	0.027	-1.300	0.235	1.6 40
OPINION	-0.010	0.007	-1.434	0.195	1.6 68	OPINION	0.005	0.021	0.211	0.839	1.6 47
Adjusted R2	0.474	F-statistic	7.834	Prob F	0.0 00	Adjusted R2	0.909	F-statistic	73.091	Prob F	0.0 00
Year Effects			Controlled			Year Effects			Controlled		
Industry Effects			Controlled			Industry Effects			Controlled		

Table (4) shows that in both cases, the auditor's economic dependence on the client weakens the effect of the common auditor on tax avoidance (The coefficient of COMMAND*ECONDEPEND variable is negative in both cases and significant at a 95% confidence level). These results show that the second hypothesis of the research has not been rejected. The economic dependence of auditors on their clients can weaken the impact of the common Auditor on tax avoidance. Several arguments can be made to explain why the auditor's economic dependence on the client diminishes the impact of a common auditor on tax avoidance. *Auditor Independence and Impartiality:* When auditors are financially reliant on a specific client, their independence can be compromised. Auditors who derive a substantial portion of their revenue from a limited number of clients might be less likely to challenge aggressive tax strategies used by these clients. Conversely, auditors are expected to use rigorous audit methods to review these tax strategies to maintain their independence and avoid regulatory penalties. This dynamic might lead to a reduction in the level of tax avoidance observed among such clients. *Compromise Incentives:* Economic dependence on clients creates financial incentives for auditors to maintain these relationships. This dependence might lead auditors to tolerate a certain degree of tax avoidance but not to the extent that it draws significant negative public attention or results in severe

penalties. Thus, auditors may be incentivized to permit some tax avoidance while avoiding actions that could lead to major repercussions. *Policy Considerations:* Many regulatory frameworks impose strict rules on auditor independence and the extent of permissible tax avoidance. Auditors who rely financially on their clients may be particularly attuned to these regulations and oversight. As a result, they may scrutinize the legality of tax avoidance strategies more carefully to avoid potential penalties or damage to their reputation.

In summary, an auditor's economic dependence on their client creates a situation where auditors must balance maintaining their client relationship with adhering to legal, regulatory, and professional standards. As a result, this dependence can diminish the auditor's ability to effectively moderate the relationship between common auditors and tax avoidance.

To test the fourth hypothesis of the research, Model (4) will be implemented as follows:

$$DELAT_iTaxAvoid_{i,t} = \alpha + \beta_1.COMAUD_{i,t} + \beta_2.ECONDEPEND + \beta_3.COMAUD\times ECONDEPEND + \beta_4.ROA_{i,t} + \beta_5.LEV_{i,t} + \beta_6.SIZE_{i,t} + \beta_7.GROWTH_{i,t} + \beta_8.PPE_{i,t} + \beta 9.INT_{i,t} + \beta_{10}.BIG4_{i,t} + \beta_{11}.OPINION_{i,t} + INDUSTRY_{i,t} + YEAR_i + \varepsilon_{i,t} \quad (4)$$

The first hypothesis is not rejected if the β3 coefficient is significant at the 95% confidence level. Table (6) shows the results of running Model (4) with two dependent variables (DELTA and ETR):

Table 6. Results of the fourth hypothesis test

DELTA						ETR					
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**VIF**	**Variable**	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**VIF**
α	-0.057	0.070	-0.812	0.420		α	-0.275	0.189	-1.453	0.154	
COMAUD	0.023	0.011	2.014	0.049	3.165	COMAUD	0.179	0.025	7.132	0.000	7.187
HHI	0.075	0.059	1.274	0.208	2.174	HHI	0.762	0.140	5.458	0.000	6.905
COMAUD*HHI	-0.091	0.032	-2.851	0.006	7.232	COMAUD*HHI	-0.334	0.051	-6.522	0.000	8.083
ROA	-0.069	0.044	-1.572	0.122	3.564	ROA	-0.502	0.161	-3.127	0.003	4.451
LEV	-0.008	0.040	-0.210	0.835	3.525	LEV	-0.043	0.122	-0.349	0.729	4.898
SIZE	0.015	0.007	2.038	0.046	2.082	SIZE	0.061	0.024	2.556	0.014	1.962
GROWTH	-0.010	0.008	-1.212	0.231	1.859	GROWTH	-0.046	0.024	-1.882	0.067	1.946
PPE	0.038	0.044	0.858	0.394	3.517	PPE	-0.547	0.190	-2.880	0.006	4.999
INT	0.055	0.018	3.100	0.003	1.997	INT	-0.186	0.050	-3.744	0.001	1.295
BIG4	-0.021	0.011	-1.914	0.061	2.088	BIG4	-0.111	0.038	-2.904	0.006	2.603
OPINION	0.010	0.007	1.398	0.168	1.743	OPINION	-0.059	0.024	-2.448	0.019	1.663
Adjusted R2	0.538	F-statistic	6.748	Prob F	0.000	Adjusted R2	0.887	F-statistic	31.832	Prob F	0.000
Year Effects			Controlled			Year Effects			Controlled		
Industry Effects			Controlled			Industry Effects			Controlled		

Table (4) shows that in both cases, the degree of concentration in the industry weakens the effect

of the common auditor on tax avoidance (The variable coefficient COMAUD*HHI is negative in both cases and significant at the 95% confidence level). These results show that the second hypothesis has not been rejected. Several arguments explain why a high level of industry concentration weakens the impact of a common auditor on tax avoidance. *Competition and Control:* These companies typically hold significant power in industries where a few firms dominate the market. High concentration and market dominance attract greater scrutiny from regulatory bodies and investors. As a result, these companies are often deterred from engaging in aggressive tax planning. Therefore, the industry concentration index, acting as a moderating variable, may weaken the relationship between the influence of common auditors and corporate tax avoidance. *Compliance with Industry Standards:* There is often stronger pressure to adhere to industry standards in highly concentrated industries. This can lead to more transparent and consistent tax practices. Auditors, in turn, are likely to discourage aggressive tax strategies that align with these standards. *Effects of Knowledge Spillovers:* Information about financial and tax practices spreads faster in industries with high concentration than in less concentrated industries. Consequently, this environment may slightly increase corporate tax avoidance, reducing common auditors' impact on tax avoidance.

In summary, the factors described above collectively create an environment where both industry-dominant firms and auditors are inclined to adopt more conservative tax practices, thereby reducing the likelihood of tax avoidance.

5. Discussion and conclusion

This article examined common auditors' impact on client companies' tax avoidance. Additionally, the moderating effects of three variables, auditor industry specialization, the auditor's economic dependence on the client, and the level of industry concentration in this relationship were also investigated. The results of the first hypothesis indicated that common auditors exacerbate the tax avoidance activities of their clients. The involvement of auditors in tax avoidance activities within companies may be driven by motivations such as attracting and increasing clients, improving long-term relationships, generating revenue, and providing a competitive advantage for these auditing firms. The results of the second hypothesis showed that the auditor's expertise in the industry is not able to strengthen or weaken the effect of common auditors on the employer's tax avoidance. This result may have appeared for various reasons, including the nature of the common auditor's influence and the creation of network relationships between common auditors and their clients, standardization of tax avoidance methods between industries, internal capabilities of companies in tax planning or attention to ethical issues of auditors. Moreover, the results of the third hypothesis indicated that the economic dependence of the auditor on the client weakens the effect of common auditors on tax avoidance. In other words, the greater the economic dependence of the auditor on the client, the less the common auditor will participate in the client’s tax avoidance activities. The reasons for these findings can be attributed to the auditors' special attention to the concepts of independence and impartiality in the auditing profession, motivations for compromise with clients, and the auditing profession's policies and regulations. Finally, the results of the fourth hypothesis also showed that industry concentration weakens the effect of common auditors on tax avoidance. In other words, the higher the industry concentration, the less the common auditors will participate in the client’s tax avoidance activities. This result may be attributed to factors such as competitive issues, special attention and oversight on industry leaders, particularly in industries that are more concentrated than others, alignment with industry standards, and ultimately, knowledge spillover effects.

Based on the findings of this research, we offer the following recommendations for the auditing and tax professions, as well as for future researchers:

a) Practical implications for the auditing and tax professions:

Strengthening Oversight of Common Auditors: Regulatory and policy-making institutions in the audit and taxation fields need to increase their monitoring of companies with common auditors. Empirical evidence suggests that these companies are often linked with higher levels of tax avoidance. Implementing specific quality control regulations for this group of auditors could lead to more accurate audit methods and reports, potentially reducing this issue.

Reducing Auditor Economic Dependence on Clients: Auditing institutions should limit their economic dependence on clients to prevent conflicts of interest that could undermine auditor independence. Measures such as setting a cap on the proportion of a company's revenue derived from a particular client or group of clients within an industry can help achieve this.

Enhancing Auditor Independence and Impartiality: It is crucial to improve regulations and standards to bolster auditor independence for the profession's sustainability and reputation. Evidence indicates that a lack of independence can lead auditors to become involved in aggressive tax planning by clients. Therefore, it is essential to strengthen auditor independence throughout all stages of the audit process, including planning, conducting audit tests, and reporting without being influenced by the auditor's expertise or concentration within a particular industry.

b) Direction future researchers:

Exploring Additional Moderating Variables: Future research could investigate other moderating factors influencing common auditors' relationship with tax avoidance. For example, factors such as corporate governance practices, cultural influences within the industry, or regulation changes could be examined.

Advancements in Audit Technologies: Future studies might also consider how emerging audit technologies for data analysis impact the relationship between common auditors and tax avoidance. These technologies could offer new methods for identifying and addressing tax avoidance strategies.

Integrating Quantitative and Qualitative Methods: Employing qualitative research methods—such as interviews, case studies, and surveys, can provide valuable insights into issues not captured through quantitative approaches. This can offer a deeper understanding and new perspectives on the topic.

By addressing these suggestions, policymakers, standard setters, and professionals in the audit and tax fields can more effectively tackle common auditors and tax avoidance issues. Additionally, future research can further illuminate the complex relationships identified in this study.

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IJAAF; Vol. 9, No. 2, Spring 2025, Serial 31

Iranian Journal of
Accounting, Auditing & Finance

Ferdowsi University of Mashhad

Quarterly

RESEARCH ARTICLE

Neural Network VS Genetic and Particle Swarm Optimization Algorithms in Bankruptcy

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How to cite this article
Azarberahman, A. (2025). Neural Network VS Genetic and Particle Swarm Optimization Algorithms in Bankruptcy. Iranian Journal of Accounting, Auditing and Finance, 9(2), 175-196. doi: 10.22067/ijaaf.2025.45564.1456
https://ijaaf.um.ac.ir/article_45564.html

ARTICLE INFO

Article History
Received: 2024-04-27
Accepted: 2024-11-11
Published online: 2025-04-15

Keywords:
Artificial Neural Networks, Bankruptcy, Genetic Algorithm, Particle Swarm Algorithm

Abstract

The goal of the study is to estimate an artificial neural network (ANN) model for bankruptcy prediction and optimize processes using the Particle Swarm (PSO) and Genetic (GA) algorithms. 21 variables that were related to the likelihood of bankruptcy were chosen for the study. Neural networks (NNs) choose the optimal network with the least error in training and evaluating patterns in the second phase. The neural network's weights and biases were optimized in the final stage by combining GA and PSO with the neural network. The results showed that the ability to explain the initial pattern has risen using GA and PSO. The evaluation of ANN performance demonstrates the superiority of the models over linear regression. Finally, four variables—current ratio, sales to current assets ratio, economic value added, and gross profit margin ratio—that may reliably predict bankruptcy were found using the ANNs-PSO and ANNs-GA hybrid approach. The evidence reveals the effectiveness of the metaheuristic algorithms compared to linear ones in predicting bankruptcy. This further highlights the new breed of computational tools available to techno-savvy financial analysts and investors.

https://doi.org/10.22067/ijaaf.2025.45564.1456

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NUMBER OF REFERENCES
59

NUMBER OF FIGURES
9

NUMBER OF TABLES
11

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

Bankruptcy is a bitter end for companies. It is a legal proceeding initiated when a company cannot pay outstanding debts or obligations. The event can mean a huge loss for the company's stakeholders. The distinction between bankrupt and non-bankrupt companies is one of the most critical issues for investors. Therefore, predicting bankruptcy is considered one of the most important investment factors (Ainan et al., 2024; Valizadeh Larijani and Banimahd, 2022). Consequently, investors must distinguish favorable from unfavorable investment opportunities. Alternatively, the research can help investors to predict bankruptcies more accurately.

One way that can help to properly utilize investment opportunities and prevent the waste of resources is to predict the financial crisis and, ultimately, bankruptcy. Companies can be warned of the financial crisis through appropriate warnings. Consequently, companies can take appropriate measures after receiving the warnings. Investors should also differentiate between favorable and unfavorable investment opportunities and invest their resources in the desired opportunities (Khani and Guruli, 2015).

Bankruptcy does not show itself quickly. It is hidden in a mass of financial and non-financial information. For example, some researchers have used financial ratios (Alam et al., 2021; Kumar and Bhattacharya, 2006; Mai et al., 2019; Beaver, 1966), multivariate analyses (Altman, 1968; Fulmer et al., 1984), multi-discriminant analyses (Deakin, 1972 and Shirata, 1998), logistic regression (Ohlson, 1980), neural networks (Letkovský et al., 2024; Wallace, 2004), genetics and vector machines (Shin et al., 2005) as financial factors on predicting bankruptcy. On the other hand, some researchers have used qualitative factors such as the company's problems in the market, financing, human power, and extra-organizational to predict bankruptcy (Vaghfi, 2019; Zarin et al., 2021).

There are two aspects to the prediction time of insolvencies: key indicators and fundamental analysis (Moghaddam and Taghi- Mollayi, 2015). The difference lies in the prediction time of bankruptcy. Key indicators can show that bankruptcy is imminent. On the other hand, fundamental analysis predicts the probability of bankruptcy in the next two to five years (Ashori, 2012).

The need for this research can be explained for several reasons. First, an accurate bankruptcy prediction helps improve investors' decision making. Therefore, it seems necessary to determine an appropriate model. Second, intelligent hybrid methods are more efficient than traditional methods in terms of cost and time. Thirdly, metaheuristic algorithms are able to make more accurate predictions.

This study addresses this gap by proposing a bankruptcy prediction model leveraging intelligent hybrid methods such as ANNs techniques. Then, the models are optimized based on GA and PSO algorithms. Thus, the problem raised is that the GA and PSO optimization model can optimize the initial bankruptcy prediction model.

The research contributes to the literature on bankruptcy in several ways. First, to the best of our knowledge, the study is the first to compare the accuracy of linear regression (LR) and ANN methods in bankruptcy prediction. Second, previous research on bankruptcy has used only one pattern to optimize ANNs (Lu et al., 2015; Azayite and Achchab, 2018). The research improves the accuracy of bankruptcy prediction by adding the genetic model. Third, the influence weight of predictor variables in neural networks was determined. This issue can help analysts to identify the most effective factors in predicting bankruptcy.

The rest of the research is organized as follows. Section 2 discusses the study's theoretical background. Section 3 presents the research hypotheses. Section 4 contains the research methodology, i.e., the database used and the methods applied for further analysis. Section 5 discusses the findings of the research and explains them in detail. Finally, section 6 provides the conclusion.

2. Literature review

Bankruptcy is when a company's liabilities exceed the market value of its assets (Gitman, 1996). Financial distress occurs when a company's realized rate of return on capital continuously and significantly falls short of the expected rate of return (Altman and Hotchkiss, 2010). Consequently, the two concepts of bankruptcy and financial distress differ. Bankruptcy is a legal situation that occurs for a company. In financial distress, however, the company continues its activities as there is no legal prohibition. Financial distress is a step before bankruptcy. Therefore, a company can be in financial distress for a long time. However, as there is no legal prohibition, it continues its activities.

Appropriate tools and models to assess a company's conditions and financial status can help with the investment decision. Predicting financial distress and bankruptcy is one of the most important tools (Zainol et al., 2024; Kou et al., 2019). The large number of companies that have run into financial distress and consequently had to file for bankruptcy has drawn the attention of researchers and market participants to this topic and has led to the development of predictive models. Predicting the financial status of the investee company will be able to protect investors. In particular, predicting the financial distress and bankruptcy of some companies after the financial crisis of 2007 and the economic recession in Europe in 2009 (Ogachi et al., 2020) and, more recently, the period of COVID-19 has become the main subject of many researches.

Financial distress is when the company cannot provide sufficient cash flow to meet its contractual obligations. Failure to end this situation in the long term negatively impacts the company's value and the shareholders' wealth. Eventually, the conditions lead to inefficiency of financial operations and bankruptcy (Wang et al., 2021). The company's bankruptcy leads to significant business losses on a global scale. Early recognition of an unfavorable situation in the company has economic advantages. This has led scientists to develop various models for predicting bankruptcy (Dasilas and Rigani, 2024; Hosaka, 2019). Developing reliable bankruptcy prediction models is important for corporate risk assessment, helps managers avoid bankruptcies and allows shareholders to screen and select investment companies (Fagerland et al. 2008). As the number of models increases, one of the challenges for researchers is to evaluate and select the best model (Mousavi and Ouenniche, 2018). The performance of bankruptcy models depends on primary data-based research and various factors such as sampling, feature selection, modeling, and performance evaluation (Jamali et al., 2021). In feature selection, researchers use different types of market information, i.e., accounting, market and microeconomic variables in distress and bankruptcy prediction models. Bankruptcy prediction models can be divided into three general categories (Jaki and Ćwięk, 2020). Scoring models obtain their data from the market. Based on financial reports, the model uses profitability, financial leverage, liquidity, solvency and activity ratios to predict the probability of bankruptcy.

Accounting-based models: beaver (1966) believes that financial ratios such as cash flow to total assets, net income to total assets, and total assets plus total liabilities to total assets are good predictors of bankruptcy in separate univariate models. Altman (1968) introduced the z-score model. Ohlson (1980) developed the o-score model based on balance sheet ratios. The index was used as an indicator of bankruptcy to perform a logistic regression. Altman et al. (1977) developed the z-score by introducing the ZETA model. The ZETA model consists of seven variables that reflect different characteristics of the company. The model performs better than the z-score in predicting bankruptcy.

The quality of forecasting models based on accounting data is criticized with regard to the source of information. The accounting data is historical data taken from the company's financial statements. In some ways, they are inconsistent with new and updated company information. Therefore, accounting-based models may be inadequate for predicting bankruptcy.

Market-based models: Merton (1974) was the first to introduce the market-based models. He

assumes that a company is considered bankrupt if it cannot pay its financial debt. In other words, if the company's debts exceed its assets, it is exposed to bankruptcy. As a result, the Merton model uses market information instead of accounting information. Although market-based models can be more accurate than accounting-based models, they have the limitations of pattern assumptions and the need to return the asset value and fluctuations.

Combined models: the models take into account both accounting information and market information together. Shumway (2001) was the first to propose this model. He proposed the discrete-time risk model, which explicitly takes time into account. Structural explanatory models based on both accounting and the market ignore the passage of time, so the estimates are biased. Shumway's model represented a major advance in the field of bankruptcy prediction because it takes time into account. Chava and Jarrow (2004) then added to the validity of Shumway's model, comparing it to scoring models. In addition, the effects of industry were also considered. Chava and Jarrow (2004) and Campbell et al. (2008) are two important combined models considering accounting and market information. Campbell et al. (2008) made two contributions in their research. First, the development of explanatory variables in the model. The market value of the share is better than the book value. The market value considers the latest market information, better reflecting the company's position. In addition, the company's intangible assets are valued more accurately. Based on this argument, Campbell et al. (2008) replaced the ratios of net income/market value of total assets and liabilities/market value of total assets with the ratios of net income/total assets and total liabilities/total assets. Second, they included the ratio of cash and short-term assets/the market value total assets as an explanatory variable in the model, reflecting the company's liquidity situation.

Today, new statistical methods in finance have entered a new phase of bankruptcy prediction. For example, artificial neural networks and metaheuristic methods have increased significantly (Alibabaee and Kan-Mohammadi, 2022; Marso and Merouani, 2020; Goletsis et al., 2009). The models also fall into the group of combined models. Some theories related to bankruptcy are mentioned below.

***Gambler's Ruin Theory*:** two players start the game with certain initial points, which are transferred from one player to the other until the player's point reaches zero. The theory states that the company can be considered a gambler who repeatedly plays at a certain loss. The gambler continues to gamble until his net worth falls below zero, i.e., until he is in financial distress (Rocha and Stern, 2004).

***Cash Management Theory*:** The short-term management of a company's cash balance is one of its main concerns. The imbalance between the input and output of flows means that the company is unable to manage its liquidity. This factor can lead to financial distress and bankruptcy (Mirarab-Bayegi et al., 2020).

Credit risk theory is the risk that a borrower will not be able to meet its obligations for any reason. Bhattacharya et al. (2020) express credit risk as the non-fulfillment of the debt commitment at the time of the parties' agreement. The models and their risk forecasts are based on the contingency theory of financial management.

Earnings behavior: companies are likely to manage incremental earnings by reducing items such as the cost of goods sold. If managers are optimistic that the firm's performance will improve in future periods, they will manipulate earnings (Graham et al., 2005). This can happen even if they are aware that their actions will be reversed in the future.

2.1 Hypotheses

The following hypotheses were formulated to answer the research problem.

H1: Bankruptcy prediction based on the artificial neural networks (ANNs) model is more accurate

than the linear regression (LR) method.

H2: Bankruptcy prediction based on a hybrid model of artificial neural networks (ANNs), genetic algorithm and particle swarm optimization (PSO) is more accurate than the linear regression method (LR).

H3: Bankruptcy prediction based on a hybrid model of artificial neural networks (ANNs), genetic algorithm and particle swarm optimization (PSO) is more accurate than the artificial neural networks (ANNs) method.

3. Research Methodology

The main objective of the research is to explain the bankruptcy prediction model using an intelligent hybrid method of neural networks and metaheuristic algorithms (genetic and particle swarm optimization). The research was conducted in three general phases. In the first phase, the data is selected and cleaned. The data is trained in the second phase, and the model is evaluated in the third phase. SPSS, Excel and Rapidminer software were used to operationalize the phases. The study's statistical population is the companies listed on the Tehran Stock Exchange (TSE) for the years 2013 to 2023, including 1791 firm-years. Banks, financial institutions, foreign companies, investment and insurance companies were not included in the study due to the specific regulatory framework for financial reporting. In addition, observations on companies that did not meet the following criteria were removed from the population:

1. The companies should have been registered with the TSE before 2013 and should not cancel the registration before 2023.
2. The data required to define the study's variables should be available in the financial statements.

The sample size based on the basis of firm-year on the above criteria is shown in Table 1.

Table 1. Sample selection procedures

	Observations
Firms listed on TSE from 2013 to 2023 [11years×560firms]	5170
Less: Firm years with insufficient information	(3863)
Less: Financial, foreign and insurance firms [11years×44firms]	(484)
Final sample	1791

The research follows a systematic and structured approach to evaluate the effectiveness of hybrid models combining Artificial Neural Networks (ANNs) with Genetic Algorithms (GA) and Particle Swarm Optimization (PSO) for bankruptcy prediction. The methodology consists of the following sequential stages:

Data Collection:

- Stage 1: identifying and selecting relevant financial data from companies listed on TSE for ten years (2013-2023), including various financial ratios and metrics.

- Stage 2: collecting annual financial statements and reports from reliable sources to ensure data accuracy and completeness.

Data Preprocessing:

- Stage 3: cleaning and preprocessing the collected data to handle missing values, outliers, and inconsistencies. Standardization of financial ratios is performed to ensure uniformity.

- Stage 4: splitting the dataset into training and testing subsets, ensuring a representative sample for model validation.

Model Development:

- Stage 5: designing the ANN model architecture, including the number of layers, neurons per layer, activation functions, and learning rate. Selection of appropriate hyper-parameters through cross-validation.

- Stage 6: GA and PSO algorithms are integrated with the ANN model to optimize the weights and biases. GA is employed for initial parameter optimization, followed by fine-tuning using PSO to achieve the best performance.

Model Training and Evaluation:

- Stage 7: training the hybrid ANN-GA and ANN-PSO models on the training dataset. Monitoring the training process to prevent overfitting and ensure convergence.

- Stage 8: evaluating the trained models on the testing dataset using performance metrics such as accuracy, precision, recall, and F1-score. Comparing the results with traditional linear regression models to assess the improvement.

Analysis and Interpretation:

- Stage 9: analyzing the results to identify the most significant financial ratios contributing to bankruptcy prediction. Performing sensitivity analysis to understand the impact of each variable.

- Stage 10: interpreting the findings in the context of existing literature and theories. Highlighting the advantages of using hybrid models over traditional methods.

Validation and Robustness Checks:

- Stage 11: conducting robustness checks to validate the stability and reliability of the hybrid models. Testing the models on different subsets of data and alternative time periods.

- Stage 12: comparing the performance of the hybrid models with other advanced computational techniques to further validate their effectiveness.

3.1 Artificial neural networks

McCulloch and Pitts (1943) introduced artificial neural networks (ANNs). ANNs consist of a large number of artificial neurons. An artificial neuron is a simple electronic pattern of a biological neuron. The number of neurons used in an ANN depends on the nature of the work to be performed. There are many ways to connect neurons to form a neural network. The most common method is the feed-forward method. The neurons of each layer send their output as a feed to the next layer, and the process continues until the final output. A NN with a maximum of two hidden layers and a sufficient number of neurons can solve the most complex problems (Ghaderi et al., 2018). However, the number of hidden layers and the neurons that compose them is usually determined by trial and error, depending on the complexity of the problem. The function of ANNs involves several actions. First, each input variable belongs to a user-defined weight in the interval from zero to one. Then, this weight is multiplied by the input value. The sum of these values reaches the neurons in the hidden layer and is added to the bias value. Then, an activation function (step, linear and/or sigmoid) acts on the neuron. The value is reweighted and passed on to the next neuron (in the next hidden layer or output layer). This way, the values obtained from all neurons in the hidden layer are collected. At this stage, one training period is completed. The predicted values obtained are compared with the observed values. The difference between the predicted and observed values is called mean squared error (MSE) (Goodfellow et al. 2016).

$$\text{MSE} = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2 \qquad \text{Eq. (1)}$$

Where n is the number of data points; Y_i the observed values, $\hat{Y}_i$ predicted values and $(Y_i - \hat{Y}_i)^2$ the squares of the errors. An algorithm corrected the error after propagation on the return path. The values of the weights are changed and a new training period begins. This process is repeated until the termination criterion of the network (i.e. the specified training period or the desired error rate) is met. Thus, the network is trained, and its performance is measured by comparing the predicted values of

the network with the observed values (Shetty et al., 2022). Figure 1 shows a schematic diagram of a fully connected feedforward network.

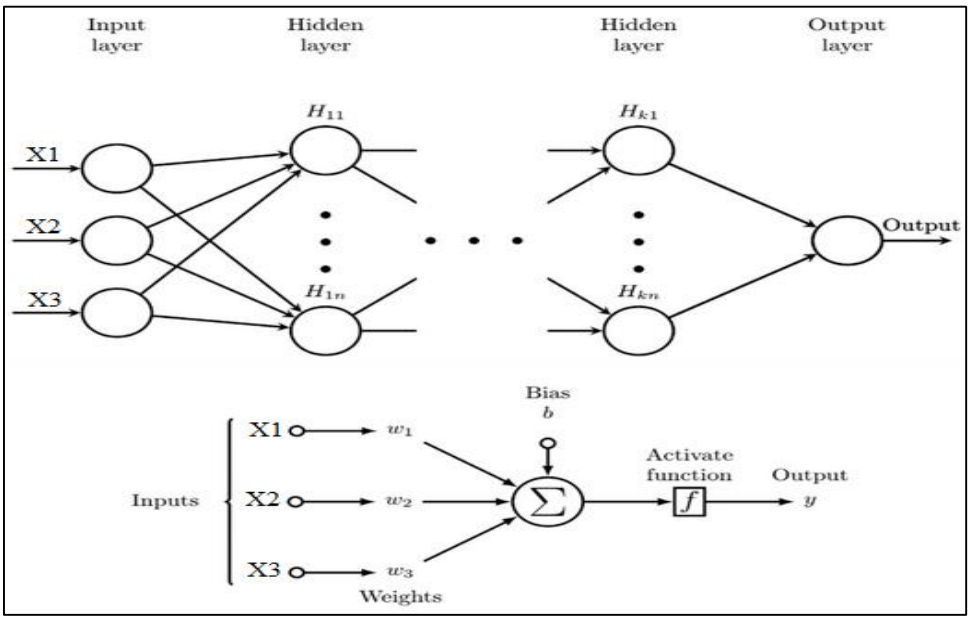


Figure 1. The upper figure is a fully connected feedforward artificial neural network (X1, X2, and X3 = input variables); the lower figure is a schematic of the computational unit of the network.

A feedforward network is said to be fully connected if each neuron in a given layer receives the outputs of the neurons in the previous layers.

3.2 Combined intelligent methods

Many predictions in finance do not follow a simple linear pattern. Rather, they are based on a non-linear and chaotic system influenced by politics, economics, psychology, *etc.* In such a situation, non-linear intelligent systems are the most suitable prediction method. Nowadays, much attention is paid to artificial intelligence (AI) to predict such cases as bankruptcy. Foroughi and Yadegari (2010) see the most important application of AI systems in finance as the prediction of variables. ANNs and metaheuristic algorithms are among the most important combined intelligent methods. They are instrumental in selecting the best information, making logical decisions, and making predictions in complex and non-linear situations (Motie Ghader et al., 2010).

Optimization refers to achieving the best result under a certain condition. The term metaheuristic is a higher-level procedure to find, generate or select a heuristic that can provide a sufficiently good solution to an optimization problem (Parejo et al., 2012). In this research, evolutionary algorithms (EA) such as genetic algorithm and particle swarm optimization are used for optimization.

3.3 Genetic algorithm

The algorithm is a metaheuristic inspired by the process of natural selection and belongs to the larger class of evolutionary algorithms. The algorithm consists of five steps, namely initialization of the population (coding), fitness function (evaluation), selection, reproduction (crossover) and convergence (mutation). During the initialization step, a population of alignments is generated that is as diverse as possible, either randomly or, for example, through dynamic programming. The population's fitness is evaluated by scoring each alignment with a specific objective function. A new

population is then created using operators such as crossover and mutation. Crossovers create a child alignment by combining two parent alignments and are important to promote the exchange of high value regions. The children can then be mutated by inserting or deleting a gap. The new offspring replaces only the weakest half of the population, while the other half is carried over into the next generation. The process ends when an empirical criterion is reached, i.e., after a certain number of generations or when no more improvement is observed (Thompson, 2016). Figure 2 shows a schematic version of the genetic algorithm.

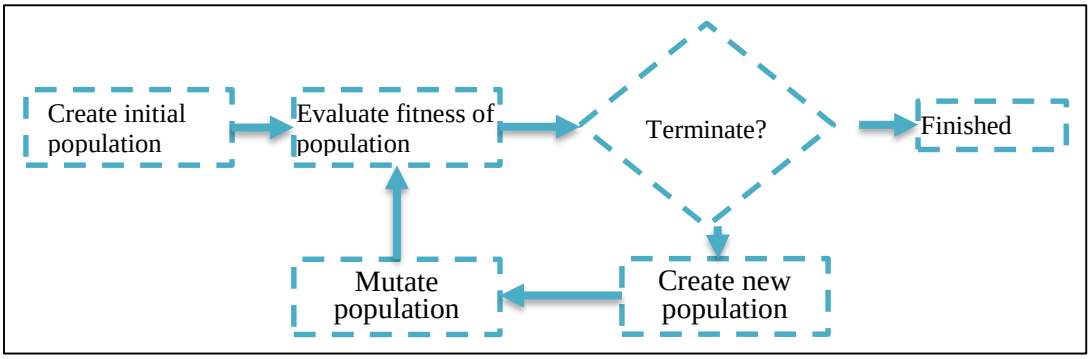


Figure 2. Typical genetic algorithm

3.4 Particle swarm optimization

The algorithm is inspired by the strategy that flocks of birds follow in their search for optimal food sources and avoid predators by "exchanging information" and thus gaining an evolutionary advantage. In a flock, a bird behaves according to its limited intelligence as well as the intelligence of the group. Each bird observes the behavior of its neighbors and adapts its own behavior accordingly. If one bird discovers a good path to food, the other birds will follow it, no matter where they are in the flock (Qin et al., 2024; Zahra et al., 2017).

The optimization problem is a position $x_{ij}(t)$ and a velocity $V_{ij}(t)$ at time *t*. Any particle's best previous position (which gives the minimum fitness value) is recorded and called the personal best (P_{best}). Another best value achieved by any particle in the neighborhood of this particle is called global best (G_{best}). Each particle updates its P_{best} and G_{best} positions with a random weighted acceleration at any given time (Kumar et al., 2013). The process is illustrated in Figure 3.

Equation 2 provides the mathematical expression for the updated position and velocity of each particle iteration t and in the search space j.

$$V_{ij}t + 1 = w \times V_{ij}t + C_1 \times r_1 \times P_{best_{ij}} - x_{ij}t + C_2 \times r_2 \times G_{best_{ij}} - x_{ij}t \qquad \text{Eq. (2)}$$

Where *w* is the inertia factor used as the control parameter for the swarm velocity, r_1 and r_2 are the random numbers between zero and one, C_1 and C_2 are the cognitive and social parameters, i.e. acceleration constants.

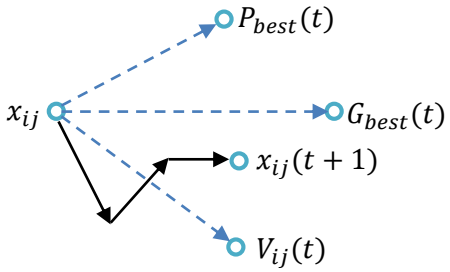


Figure 3. Update the diagram of the individual particles in the swarm

4. Research finding

The study's dependent variable is bankruptcy, which results from the following formula.

$$\zeta = 1.2A + 1.4B + 3.3C + 0.6D + 1.0E \qquad \text{Eq. (3)}$$

Where Zeta (ζ) is Altman's Z-score; A is the working capital/total assets ratio; B is the earnings/total assets ratio; C is the EBIT/total assets ratio; D is the market value of equity/total liabilities ratio and E is the total sales/total assets ratio. If the ζ-value of a company is less than 1.8, it is described as bankrupt. The range between 1.8 and 3 is the grey zone and more than 3 is the safe zone. The spread of ζ is shown in Figure 4.

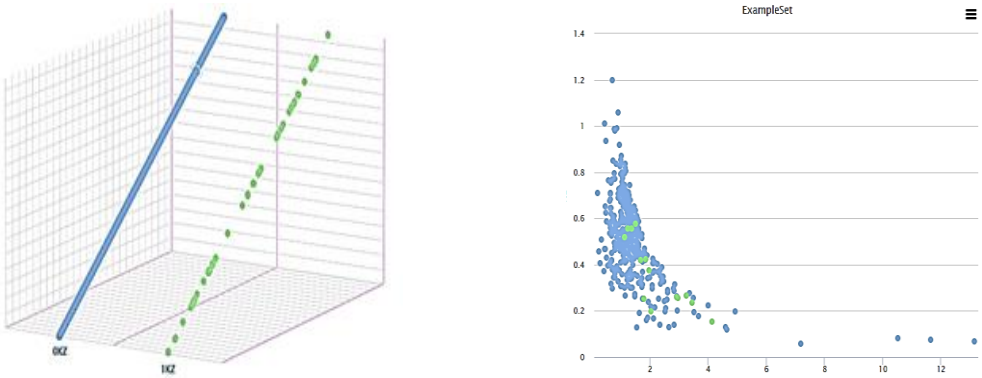


Figure 4. Dispersion of ζ (● healthy firms and ● bankrupt firms)

According to Table 2, Predictor variables are determined to achieve the research objectives.

Stepwise linear regression is used to clarify and select predictor variables. The aim is to determine the variable that influences the prediction of bankruptcy. To include independent variables in the stepwise linear regression model, the variable that has the highest correlation with the dependent variable is selected first. Then, the second variable is included in the analysis, which causes the largest increase in the coefficient value after separating the previous variable. In this way, the variables are

entered into the model one after the other until the error rate is less than 5%.

Table 2. Predictor variables

		Accounting measures:
X1	Current ratio	The ratio of current assets to current liabilities.
X2	The short-term liability to assets ratio	Short-term liabilities are divided by assets.
X3	Basic Earning Power	The ratio of EBIT divided by total assets.
X4	The operating cash ratio	The ratio of operating cash divided by total assets.
X5	Market-to-book ratio	Share price divided by net book value per share.
X6	The accounts receivable to assets ratio	The ratio of accounts receivable divided by total assets.
X7	The sales to current assets ratio	The ratio of net sales divided by current assets
X8	Economic value added (EVA)	EVA= NOPAT – (Invested Capital × WACC). NOPAT is net operating profit after tax; Invested Capital is Debt + capital leases + shareholder's equity; and WACC is the weighted average cost of capital.
X9	The asset turnover ratio	Net sales are divided by average total assets.
X10	The retained earnings to total assets ratio	The ratio of retained earnings divided by total assets
X11	The retained earnings to shareholder's equity ratio	The ratio of retained earnings divided by shareholder's equity
X12	The gross profit margin ratio	[(Net revenue – direct expenses)/net revenue]×100%
X13	The long-term debt to equity ratio	Long-term debt divided by shareholders' equity.
X14	Net profit margin	The ratio of net income to sales.
X15	Cost of goods ratio	The ratio of cost of goods sold to sales.
		Firm risk measures:
X16	Systematic risk	Systematic risk measures the degree to which a particular investment's return changes relative to changes in return. $\beta = Cov(R_m.R_i)/\delta^2 R_m$
X17	Financial risk	The ratio of liabilities to assets.
		Corporate governance (managerial) measures:
X18	Non-executive directors	The ratio of non-executive directors to all members of the board.
X19	Institutional ownership	The total number of shares owned by shareholders is more than 5%.
		Macroeconomic measures:
X20	Inflation	Annual inflation announced by the central bank.
X21	GDP	Gross Domestic Product announced by the central bank.

Stepwise linear regression can be interpreted if the classical regression assumption is controlled. The normality of the dependent variable should be tested. This is because its normality leads to the normalization of the model's residuals. The Kolmogorov-Smirnov test was used to test normality. The normality of the sample is confirmed if the P-value is greater than 5%. A P-value of 0.065 was confirmed here. The independence of the residuals is a further regression assumption. The interpretation of the regression results is incorrect if the error values are correlated with each other. The Durbin-Watson statistic is suitable for testing the independence of the residuals. The calculated value is 1.721. The assumption of a correlation between the residuals is rejected if the Durbin-Watson statistic is between 1.5-2.5. The result shows that the residuals are independent of each other. In other words, there is no autocorrelation between the errors. Then, the t-test is used to select the variables whose significance level is less than 5% by calculating the coefficient of determination suitable for entering the model. Table 3 shows the status of the variables.

Table 3. General status of the variables

Variable	Result	Variable	Result	Variable	Result
X1	Accept	X8	Accept	X15	Accept
X2	Accept	X9	Reject	X16	Reject
X3	Accept	X10	Reject	X17	Accept
X4	Accept	X11	Reject	X18	Reject
X5	Reject	X12	Accept	X19	Accept
X6	Reject	X13	Accept	X20	Reject
X7	Accept	X14	Accept	X21	Reject

The linear model can be presented as equation 4.

$$\zeta = .191 - .091X1_{i.t} + .0128X2_{i.t} - .0161X3_{i.t} - .987X4_{i.t} - .501X7_{i.t} - .091X8_{i.t} - .013X12_{i.t} + .009X13_{i.t} - .005X14_{i.t} + .359X15_{i.t} + .021X17_{i.t} - .0192X19_{i.t} \quad \text{Eq. (4)}$$

Table 4. Multiple correlation coefficient of variables

Variable	P-value	Improved determination coefficient R^2	Multiple correlation coefficient
X1	0.000	0.412	0.655
X2	0.000	0.562	0.699
X3	0.000	0.546	0.702
X4	0.000	0.591	0.721
X7	0.001	0.501	0.781
X8	0.000	0.601	0.770
X12	0.002	0.623	0.784
X13	0.001	0.599	0.795
X14	0.003	0.600	0.745
X15	0.000	0.669	0.799
X17	0.003	0.544	0.765
X19	0.001	0.619	0.749

According to Table 4, The 10-fold cross-validation was applied to test the generalizability of the prediction. The method is completely reliable and sufficient to predict the actual error rate (Ellis and Mookim, 2013). In the method, the data set is shuffled. Then, the data set is divided into 10 subsamples. In the first iteration, nine samples are used as training data and the rest as test data. The model is trained with the training data and evaluated with the test data. The evaluation results or the error rate are retained and the model is discarded. In the next iteration, a subset is selected as test data, and everything is repeated. The iteration is repeated k times until all data is considered. Finally, the total error rate is the average of all individual evaluation results.

Criteria were used to evaluate the efficiency of networks with different structures and to determine the best one. (1) Mean Square Error (MSE); (2) Root Mean Square of Errors (RMSE); and (3) the correlation coefficient (R). The network with the lowest values of the two aforementioned errors whose R coefficient is closest to one is considered the best. The first criterion represents the average error between the obtained and measured results.

$$MSE = \frac{\sum_{i=1}^{N}(O_i - T_i)}{N} \quad \text{Eq. (5)}$$

Where T_i and O_i are the estimated and actual values, respectively and N are the available data

pairs. The second criterion indicates the average error between the actual and predicted data. The criterion is calculated from equation 6.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(O_i - T_i)}{N}} \quad \text{Eq. (6)}$$

The third criterion is the correlation coefficient between the values predicted by the NN and the output data of the numerical modeling. The criterion is calculated from equation 7.

$$R = \frac{\sum_{i=1}^{N}(O_i - \bar{O}_i)(T_i - \bar{T}_i)}{\sqrt{\sum_{i=1}^{N}(O_i - \bar{O}_i)^2 - \sum_{i=1}^{N}(T_i - \bar{T}_i)^2}} \quad \text{Eq. (7)}$$

Where $\bar{T}_i$ and $\bar{O}_i$ are the average of estimated and actual values respectively.

4.1 The best network

Training NN aims to determine the weights to obtain the best network for modeling the objective function. Supervised learning is one of the best types of learning (Foroughi and Yadegari, 2010). In supervised learning, the training data consists of inputs (feature vectors) paired with correct outputs (labels). Therefore, the feature vectors assume the correct output labels. During training, the algorithm searches for patterns in the feature vectors related to the labels. It trains the patterns. After training, new feature vectors whose labels are unknown are identified. Based on the previous training, it is determined which label belongs to the new feature vector. Therefore, a supervised learning model aims to predict the correct label for new feature vectors. NN structures were used in Table 5.

Table 5. Different neural network structures

Pattern	No. of hidden layers	No. of first layer neurons	No. of second layer neurons	No. of output layers
ANN-I	1	10	6	2
ANN-II	1	12	8	2
ANN-III	1	14	10	2
ANN-IV	2	10	6	2
ANN-V	2	12	8	2
ANN-VI	2	14	10	2

The number of neurons in the hidden layers is determined by trial and error and does not follow a specific rule. The network is not able to train if the number of neurons is too low. In addition, ultra-learning occurs when the number of neurons is large. The modes increase network error (Charalambous, 2023; Motie Ghader et al., 2010). The modeling process of NNs in Rapidminer software is shown in Figure 5.

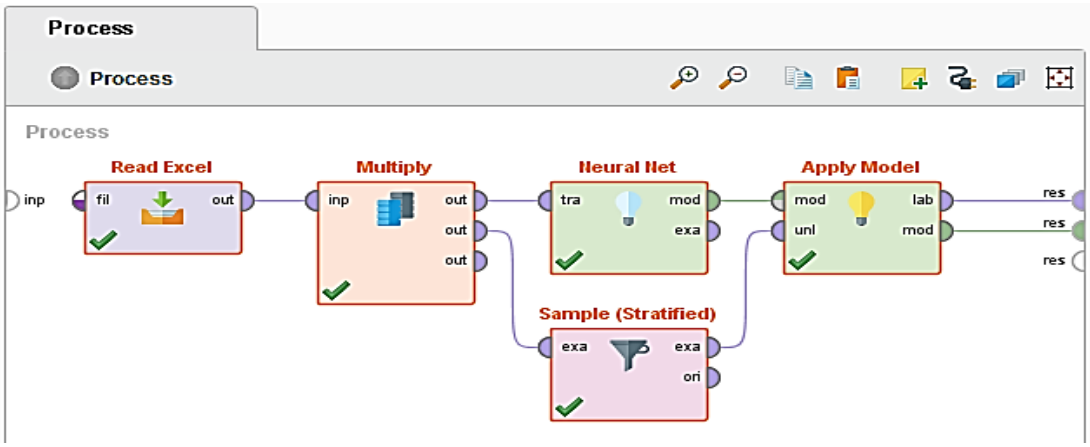


Figure 5. Modeling process in the software

Table 6 shows the values of different artificial network structures' R, MSE, and RMSE.

Table 6. R, MSE, and RMSE

Pattern	R		MSE		RMSE	
	Training	Evaluating	Training	Evaluating	Training	Evaluating
ANN-I	0.800	0.759	0.097	0.115	0.314	0.318
ANN-II	0.861	0.819	0.043	0.066	0.215	0.256
ANN-III	0.842	0.817	0.066	0.078	0.261	0.281
ANN-IV	0.830	0.802	0.058	0.072	0.242	0.265
ANN-V	0.812	0.758	0.102	0.112	0.275	0.333
ANN-VI	0.852	0.822	0.061	0.065	0.215	0.255

Table 6 shows that the best pattern is ANN-II. In the training phase, the R, MSE and RMSE values are 0.861, 0.0436 and 0.2152, respectively. The values in the evaluation phase are 0.819, 0.0666 and 0.2560. The process is shown in Figure 6. The values of the evaluation phase indicate that all examples (feature vectors) have been trained well and are able to predict bankruptcies.

4.2 Genetic and particle swarm optimization algorithms

Metaheuristic algorithms use a relatively similar mechanism to find the optimal solution. In most algorithms, the search begins by generating a set of random solutions within the allowable range of the decision variables. The set of solutions in each algorithm has names such as swarm, colony, group, etc. Names such as particles, chromosomes, ants and the like are assigned to each solution. Then, a set of new solutions with operators is generated. The process continues until the stopping criterion is reached (Sharifzadeh and Amjady, 2014). The performance of the two algorithms used in the research is based on swarm. Therefore, the combination of the two algorithms with the NN shows different performance due to their nature. The purpose of combining algorithms with NN is to optimize the weights and biases of the NN. Algorithms are swarm-oriented in nature. Therefore, the problem should be defined in such a way that it can be optimized as a swarm. In the problem definition phase, the chromosomes or particles should be such that the weights and biases are optimized. Therefore, the number of genes of each chromosome should be equal to the number of weights and biases. The program is executed 10 times to perform the necessary validation. In each execution, a combination of the input patterns was determined to optimize the factors affecting the bankruptcy. Finally, the best solutions (variables) were compared based on the values of R and MSE. The modeling process of

PSO in software is shown in Figure 7.

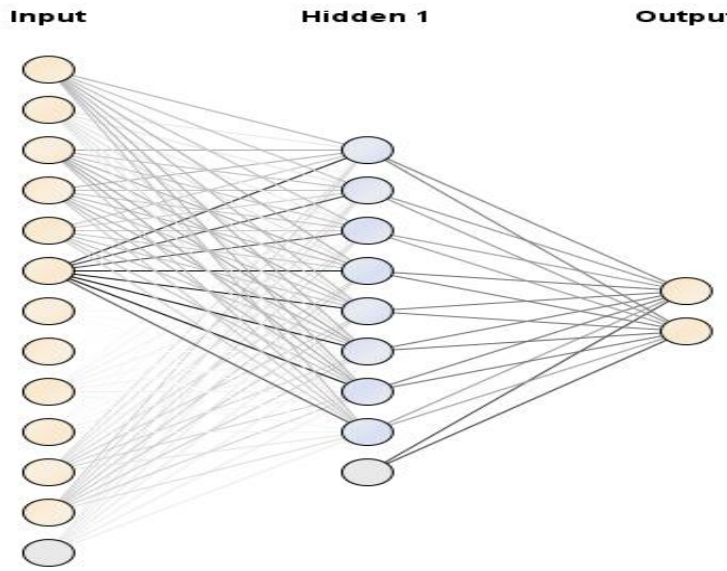


Figure 6. The best NN model

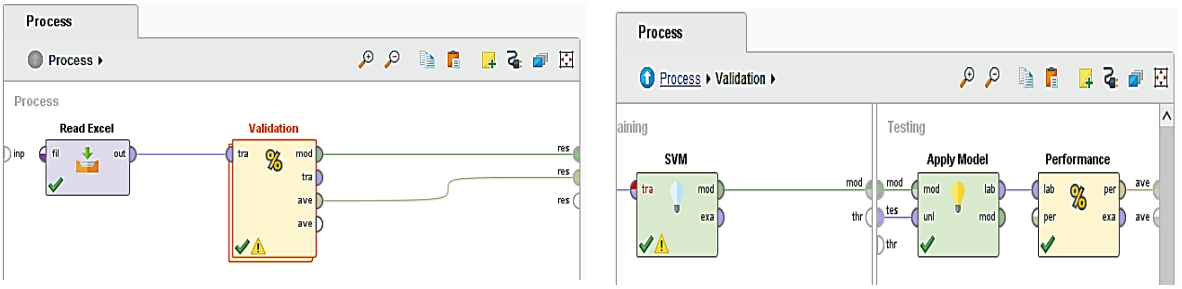
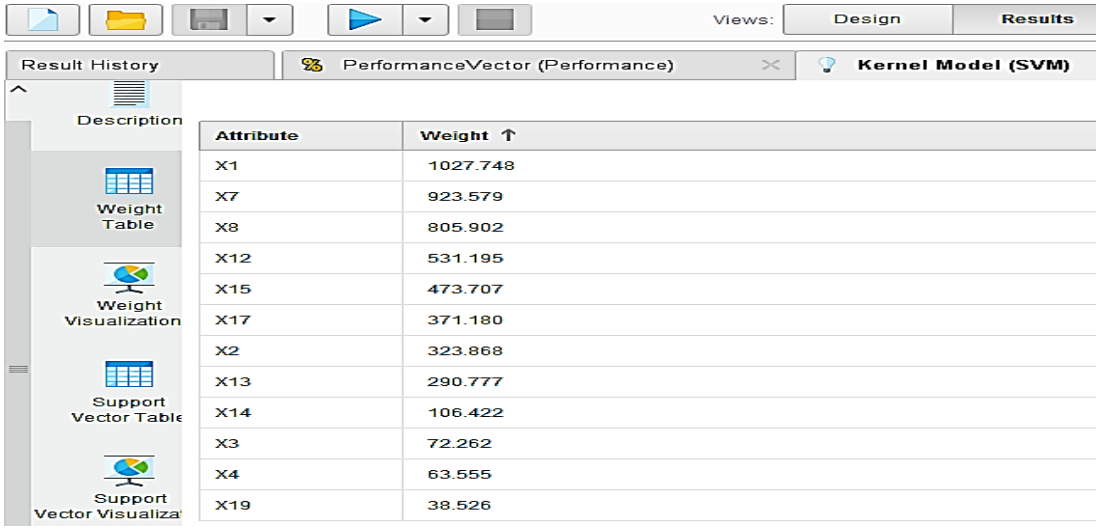


Figure 7. Modeling process in the software

The nonlinear Support Vector Machine (SVM) based on the Gaussian Kernel was used in the optimization model for data classification. The method is suitable for searching for the best parameters of the SVM and selecting the best feature. The results of the Kernel test can be found in Figure 8.



Attribute	Weight ↑
X1	1027.748
X7	923.579
X8	805.902
X12	531.195
X15	473.707
X17	371.180
X2	323.868
X13	290.777
X14	106.422
X3	72.262
X4	63.555
X19	38.526

Figure 8. The Kernel model result

The results of the Kernel model show that features (variables) with a higher weight have a higher accuracy. This means that they have more influence on the bankruptcy model. The features are listed in Figure 8. The performance of the algorithms can be illustrated using a confusion matrix. The error in predicting healthy firms can be neglected, but not for bankrupt firms. In other words, the expectation is to predict bankrupt firms without leaving even one bankrupt firm. The confusion matrix is useful when the accuracy and precision in predicting one feature are vital for comparing the overall prediction. The confusion matrix is shown in Figure 9.

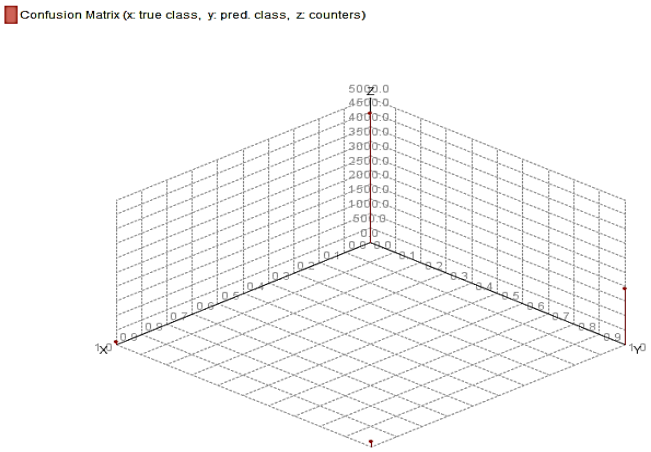


Figure 9. Confusion matrix

Table 7 shows the error value indices of the research models. Compared with other patterns, the combination of ANNs and PSO (ANNs-PSO) can reduce the MSE error and increase the correlation coefficient. On the other hand, linear regression (LR) has the highest rate and the lowest correlation.

The results in Table 7 show that the ANNs-PSO pattern can almost handle new data. Therefore, the efficiency of the pattern towards the prediction of bankruptcy is proven.

Table 7. Comparative values of R and MSE indices of the research model error

Pattern	R		MSE		Correlation coefficient difference b/w training and evaluating
	Training	Evaluating	Training	Evaluating	
LR	0.799	0.767	.0997	0.117	0.059
ANNs	0.849	0.828	.0467	0.067	0.038
ANNs-GA	0.866	0.839	0.039	0.055	0.023
ANNs-PSO	0.878	0.861	0.027	0.046	0.015

4.3 Test of research hypotheses

The paired t-test is suitable to test hypotheses and determine significant differences between the patterns. Prior to this, the normality of the MSE indices is tested using the Shapiro-Wilk test, according to Table 8.

Table 8. Results of the Shapiro-Wilk

MSE index	LR	ANNs	ANNs-GA	ANNs-PSO
Shapiro-Wilk P-value	0.112	0.327	0.341	0.491

A P-value of more than 5% in the Shapiro-Wilk test means that the MSE indices are normal.

The t-test results in Table 9 show a significant difference in all performance criteria between a pair of predictor patterns. The 10-fold cross-validation is used to compare the predictive accuracy of the patterns. Cross-validation is typically used in applied machine learning to compare and select a pattern for a particular predictive modeling problem.

Table 9. T-test results

Paired patterns	t statistic	P-value	10-fold cross-validation (more accuracy)
LR – ANNs	43.651	0.001	ANNs
LR – GA	50.214	0.000	GA
LR - PSO	38.229	0.001	PSO
ANNs – GA	11.588	0.000	GA
ANNs – PSO	31.334	0.001	PSO
GA – PSO	51.647	0.001	PSO

The result of the t-test for the LR and ANNs patterns shows that the MSE value of the two patterns has a significant difference at the 5% error level. The cross-validation result confirms that the ANNs pattern can have higher optimization accuracy with lower error. Therefore, the first hypothesis of the study is confirmed.

The results of Table 9 show that the MSE value of the LR pattern has a significant difference with the GA and PSO patterns at the 5% error level. The result indicates that the two patterns are different, and the hybrid pattern of ANNs, GA, and PSO may have a higher optimization accuracy and a lower average error. Therefore, the second hypothesis of the study is confirmed.

The cross-validation results also show that considering the hybrid patterns of ANNs, GA and PSO have a lower average error than the ANNs pattern. Therefore, the third hypothesis of the study is confirmed.

The results of ranking the patterns based on the higher accuracy in predicting bankruptcies are shown in Table 10.

Table 10. The ranking of patterns in predicting bankruptcy

Rank	MSE training error	MSE evaluating error	Result test (more accuracy)
1	0.019	0.048	PSO
2	0.027	0.059	GA
3	0.040	0.072	ANNs
4	0.124	0.151	LR

The PSO pattern has fewer training and evaluation errors compared to the others and takes first place.

4.4. Key variables for bankruptcy prediction

Table 11 shows the importance of the predictor variables in ANNs, GA and PSO based on the ratio of the accuracy of the variables to the overall accuracy of the variables.

Table 11. Key variables for predicting bankruptcy

Variable	$(ANNs)^1$	$(GA)^2$	$(PSO)^3$	(2-1)	(3-1)	Selection
X1	17.41%	18.62%	19.01%	+ 1.21%	+ 1.6%	◀ Best
X2	4.68%	3.57%	5.08%	- 1.11%	+ .4%	
X3	4.25%	1.08%	2.88%	- 3.17%	- 1.37%	
X4	3.53%	5.10%	1.39%	+ 1.57%	- 2.14%	
X7	15%	18.01%	17.24%	+ 3.01%	+ 2.24%	◀ Best
X8	14.73%	14.89%	15.93%	+ .127%	+ .136%	◀ Best
X12	12.31%	12.51%	13.44%	+ .109%	+ .117%	◀ Best
X13	5.45%	4%	5.68%	- 1.45%	+ .23%	
X14	3.51%	2.71%	3.91%	- .8%	+ .4%	
X15	11.39%	9.90%	12.21%	- 1.49%	+.82%	
X17	5.88%	6.05%	.223%	+ .17%	- 5.66%	
X19	1.86%	3.56%	1%	+ 1.7%	- .86%	
Total	100%	100%	100%	-	-	-

The ANNs confirmed the predictive power of 12 variables, including X1, X7, X8, X12, X15, X17, X2, X13, X14, X3, X4, and X19 respectively. The combined model is used for optimization. The optimization is performed when the MSE error leads to an increase in accuracy. The hybrid ANNs-GA identified 7 optimized variables, including X1, X7, X8, X12, X17, X4 and X19 respectively. The hybrid ANNs-PSO identified 8 optimized variables, including X1, X7, X8, X12, X15, X2, X13, and X14. It can be inferred that the ANNs-PSO is the best method for predicting bankruptcies by optimizing the variables at the lowest error level.

5. Conclusion

The study's exploration of predictive modeling techniques for financial risk assessment offers valuable insights into the limitations of linear statistical analysis and the potential of non-linear approaches, particularly ANNs combined with metaheuristic optimization algorithms like GA and PSO. An important limitation of linear models is the lack of a direct indicator that best represents the data in a linear condition. Therefore, linear statistical analysis is often inappropriate, which is the nature of social sciences. With linear patterns, the basic pattern must be established in advance. The basic pattern makes the problem easier to solve. But it requires a lot of guesswork. In addition, the pattern depends on various assumptions, such as the absence of multiple linear correlations and the normal distribution of the residuals.

It can be concluded that using non-linear NN models can increase the model's efficiency. On the other hand, the evaluation of the performance of the hybrid models of ANNs, GA algorithm and particle swarm showed the superiority of the models compared to the linear regression model and the NN. In general, it can be stated that metaheuristic algorithms such as genetic algorithms and particle swarm algorithms as a supplement to the NN increase prediction accuracy. The increase in accuracy can lead to different results. The study also identifies four key financial ratios: current ratio, sales to current assets ratio, economic value added, and gross profit margin ratio, which are significant bankruptcy predictors.

One key lesson from the study is the importance of leveraging advanced modeling techniques to overcome the limitations of traditional linear approaches. The success of hybrid models combining ANNs with metaheuristic algorithms highlights the value of integrating diverse methodologies to enhance prediction accuracy and robustness. While the study demonstrates the effectiveness of hybrid modeling approaches, it is not without limitations. One notable limitation is the reliance on historical financial data, which may not fully capture the dynamic nature of financial markets. Additionally, the study's focus on bankruptcy prediction may limit its applicability to other financial risk domains. Therefore, future research could explore applying hybrid modeling techniques to other financial risk scenarios beyond bankruptcy prediction. Additionally, investigating the impact of incorporating alternative data sources such as sentiment analysis and social media data could further enhance predictive accuracy and broaden the scope of financial risk assessment.

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