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THE IMPACT OF ARTIFICIAL INTELLIGENCE ON INTERNAL CONTROL IN JORDANIAN INDUSTRIAL COMPANIES

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Abstract

This study endeavored to discern the effect of artificial intelligence on the efficiency and effectiveness of internal control of Jordanian companies of industry. The researchers followed a descriptive-analytic approach. The population of the study encompassed Jordanian public shareholding industrial companies, totaling 46 companies distributed across 9 different industrial sectors. A total of 230 questionnaires were distributed, with an average of 5 questionnaires per company. The study targeted employees in the finance, control and internal audit departments of Jordanian public shareholding industrial companies, specifically those holding positions such as Financial Manager, Head of Accounting Department, Internal Auditor, and Accountant. One of the most significant findings of the study is that the dimensions of artificial intelligence; i.e. ("artificial neural networks", "machine learning", "expert systems and genetic algorithms") affect both the efficiency and effectiveness of internal control in the industrial companies in Jordan. Among the key recommendations made by the researchers is that industrial companies should provide the appropriate infrastructure and specialized training programs to qualify employees to use artificial intelligence tools and techniques to ensure their ability to utilize them effectively.

Keywords: Artificial Intelligence, Internal Control, Jordanian Industrial Companies.

1. INTRODUCTION

Intelligence is considered one of the traits and characteristics with which God Almighty has distinguished humans from all other creatures. Over time, humans have realized that intelligence is the source of their strength and uniqueness, and they can make substantial use of it in computers. Many scientists have attempted to study the trait of intelligence in humans and all other creatures, and later worked on finding an effective way to transfer intelligence to machine after confirming that machine does not possess this trait. The field of artificial intelligence has gone through significant phases until artificial intelligence (machine learning) emerged across various activities and sectors, including health, finance, security, education, and the military (Qasaimeh, 2021).

1.1 Research Problem and Questions:

The problem of the study in the scope of the fact that most Jordanian industrial companies seek to enhance the efficiency and effectiveness of internal control due to its direct impact on ensuring the accuracy of statistical and accounting data, achieving maximum production efficiency, and ensuring that employees adhere to established policies and plans. With the emergence and spread of many modern and advanced technological systems and techniques

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and their entry into various sectors, along with their clear impact on Jordanian industrial companies, it became necessary for these organizations to rely on and pursue information technology, as well as adopting artificial intelligence software and processes across various administrative levels and all sectors. This contributes to improved performance, maximized profits, and enhanced efficiency and effectiveness of internal control, providing all the required steps in the appropriate and suitable ways with high quality.

Consequently, the following questions describe the problems that are covered in this study:

Main Research Question: Are the efficacy and efficiency of internal control in Jordanian industrial businesses affected by AI in its different forms, such as "expert systems", "artificial neural networks", "genetic algorithms", and "machine learning"?

The following follow-up (sub) questions can be derived from this primary question.

1. Do expert systems have any effect on the efficacy and efficiency of internal control in the industrial businesses in Jordan?
2. Do artificial neural networks have an influence on Jordanian industrial businesses' internal control efficacy and efficiency?
3. Do genetic algorithms affect the efficacy and efficiency of internal control in industrial companies in Jordan?
4. Does machine learning have an influence on Jordanian industrial businesses' internal control efficacy and efficiency?

1.2 Research Significance:

This study is significant because it emphasizes artificial intelligence as one of the modern trends in the realm of advanced and vital information technology for industrial companies of all kinds. To the major of the researcher's knowledge, this study is also significant because it is the first to measure how artificial intelligence affects internal control in industrial sectors. In order to comprehend the relationship between "artificial intelligence" and its various dimensions- "expert systems", "artificial neural networks", "genetic algorithms", and "machine learning"—in the context of Jordan's industrial workplace, this study will create a theoretical framework that clarifies the independent variable and describes internal control.

The study targets the sector of industrial of the companies listed on the "Amman Stock Exchange/ Jordan". Consequently, the practical importance revolves around the importance of industrial companies of Jordanian, which constitute the study population. Additionally, the study aims to draw the attention of managers and decision-makers and provide them with the most key flexible practices that can lead companies to apply modern methods that enhance the efficiency and effectiveness of internal control, maximize profits, and improve performance. Moreover, it seeks to increase the companies' ability to adapt to prevailing technological developments.

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1.3 Research Objectives:

The objectives and goals of the study are stated in the following points:

1. To investigate how artificial intelligence methods, such as machine learning, artificial neural networks, expert systems, and genetic algorithms affect the efficacy and efficiency of internal control in Jordanian industrial companies. The following sub-objectives is derived from this primary objective:

- To determine how expert systems affect Jordanian industrial companies' internal control effectiveness and efficiency.
- To determine how artificial neural networks affect Jordanian industrial businesses' internal control efficacy and efficiency.
- To determine how genetic algorithms affect Jordanian industrial companies' internal control systems' efficacy and efficiency.
- To determine how machine learning affects Jordanian industrial companies' internal control's efficacy and efficiency.

1.4 Research Hypotheses

The following theories were developed in order to address the research's inquiries and accomplish its goals:

Main Hypothesis 1: The efficiency and effectiveness of internal control the industrial companies in Jordan are not statistically impacted by artificial intelligence in its different dimensions ("artificial neural networks", "genetic algorithms", "expert systems", and "machine learning") at the level of significance ($\alpha \leq 0.05$).

From this primary hypothesis, a number of sub-hypotheses are developed:

- Sub-hypothesis 1: Expert systems have no statistically significant effect on the efficacy and efficiency of internal control in Jordanian industrial businesses at the significance level ($\alpha < 0.05$).
- Sub-hypothesis 2: Artificial neural networks have no significant statistically results effect on the efficacy and efficiency of internal control in Jordanian industrial businesses at the significance level ($\alpha \leq 0.05$).
- Sub-hypothesis 3: "Genetic Algorithms (GA)" have no statistically significant influence on the efficacy and efficiency of internal control in Jordanian industrial businesses at the significance level ($\alpha < 0.05$).
- Sub-hypothesis 4: Machine learning has no statistically significant influence on the efficacy and efficiency of internal control in "Jordanian Industrial Businesses (JIB)" at the significance level ($\alpha < 0.05$).

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2. THEORETICAL FRAMEWORK

2.1 Artificial Intelligence: A Definition Several scholars in this field have voiced diverse viewpoints on the idea of artificial intelligence. From the newest to the oldest, an overview of the main ideas from a variety of time eras is provided here:

The definition of artificial intelligence is a technology that, by means of its capacity for ongoing learning and intelligent evolution, assists in carrying out and completing activities in a way that is comparable to that of the human who developed it and gave it information (Martins, 2024).

The definition of artificial intelligence is a technology that, by means of its capacity for ongoing learning and intelligent evolution, assists in carrying out and completing activities in a way that is comparable to the performance of the person who developed it and gave it information. It is a crucial technology that promotes economic activity, advances a nation's economy, and aids in the resolution of several social issues in the last several years (Batolar & Kaur, 2020).

The term "artificial intelligence" describes learning systems that carry out tasks creatively and look for ways to provide humans the best choices from the options available (Goksel & Bolkurt, 2019).

By using algorithms principally and fundamentally, **the researchers get to the conclusion** that artificial intelligence may be described as the capacity of a mind of computers to learn from its surroundings (data gathering and machine learning) without being literally pre-programmed.

2.2 Artificial Intelligence Techniques:

1) Expert System:

Expert systems are essentially computer programs created to simulate the expertise and problem-solving skills of a human expert. That is to say, the foundation of an expert system is the idea of using a human expert to model existing knowledge, which is then programmed and stored in the knowledge base of an information system associated with a particular field of study and activity. This allows the system to take the position of the human expert and fulfill their function in resolving intricate administrative issues via the end user (Shehadeh, 2023).

There are several benefits of expert systems, including: they offer multiple and significant advantages to both artificial intelligence and computer systems. They aim to provide the highest level of reliability and objectivity in making appropriate decisions efficiently and effectively while maintaining rationality, neutrality, and abstraction in dealing with emotions, feelings, desires, psychological conditions, and pressures when making appropriate and important decisions. Expert systems help support decision-making processes that are unstructured and difficult to solve due to complex and challenging classification, and they eliminate the high financial cost paid to human experts compared to expert systems. They can be used without time constraints and in any location, and they help address the issue of losing the accumulated knowledge of human experts due to retirement, resignation, illness, or death (Bragazzi et al., 2020).

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The researchers define expert systems as the knowledge and expertise acquired by the management and cost accountant over time. Artificial intelligence software is created and designed and provided with the accumulated knowledge and expertise gained by the management accountant. These software programs function as experts (intelligent systems that perform the work of experts).

2) Artificial Neural Networks:

Artificial neural networks are an interconnected set of virtual neurons created by computer programs. They use a method similar to how human brain cells think, deduce, and analyze data by providing the computer with vast amounts of data from which it learns and produces appropriate outputs. Since these neurons resemble the human brain, this means they constantly develop and change themselves, learn, and modify data analysis methods to avoid errors through multiple layers, each dedicated to a specific task. They are one of the techniques of artificial intelligence, characterized by their ability to learn and generalize. For this reason, they are widely applied, as they can model nonlinear systems when the relationship between variables is unknown or highly complex (Yang & Wang, 2020).

Conversely, "Artificial Neural Networks (ANN)" function similarly to the human nervous system in terms of information processing, with the primary difference being the system's structure, which handles vast volumes of disconnected data to address particular issues (Rashwan & Al helou, 2020).

There are several benefits of expert systems, including the significant advantage of artificial neural networks in their ability to extract new meaning from large amounts of data with high efficiency, extracting patterns, and detect highly complex trends, leading to results not previously observed by humans. Artificial neural networks contribute to extracting patterns and revealing trends that are extremely complex, achieving results not noticed by humans or other computer techniques. They assist in their ability to learn according to complex and difficult relationship models and the possibility to generalize after learning from initial inputs, making them the best model for use with diverse, unstable, and volatile data. Additionally, artificial neural networks help accomplish tasks in a timely and appropriate manner with efficiency and effectiveness (Qasaimeh, 2021), (Abu joma, 2021).

The researchers view artificial neural networks as a science that seeks to produce software that operates based on the same concept as the human mind. This is achieved by providing the program with a large set of data, which it analyzes, learns from, and then produces suitable outputs. Accordingly, artificial neural networks consist of a device containing several processors with multiple memories interconnected in parallel, enabling them to perform tasks in the same way as neurons in the human brain.

3) Genetic Algorithms:

Genetic algorithms are a type of computer program that mimics biological processes to efficiently and effectively analyze problems in evolutionary systems. Genetic algorithm techniques, in their current form, were introduced in 1975 by John Philip Holland at the

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University of Michigan in the United States and developed in the early 1980s and they have become one of the most prominent and effective methods for dealing with complex search and inquiry problems. They are described as "genetic" because they rely on simulating the functioning of genetic genes to reach the optimal and best solution. Genetic algorithms are considered a topic of artificial intelligence that mimics human learning processes and follows statistical models that execute instructions based on conclusions rather than direct instructions from the model creator. Thus, they have the ability to continuously improve and develop their capabilities according to variables related to the nature and trends of the data effectively (Shehadeh, 2023), (Al-sayyed et al., 2021).

Genetic algorithms as a form of optimization algorithm, meaning their function is to search for the optimal solution to a specific computational problem to achieve a goal that could be a maximum or minimum value. Genetic algorithms are based on a biological principle and are used to solve complex problems. They start by transforming the problem or task into a mathematical equation, which has a variety of solutions: some incorrect and some correct, and there is an optimal and suitable solution that the "genetic algorithm" can reach (Carr, 2014).

From this, the researchers conclude a definition of "genetic algorithms" as a type of software used during the search for the optimal solution, especially in difficult and complex problems where it is challenging to find a mathematical relationship between their variables, or those that require a long time to solve. They work by imitating the function of genetic genes through their search for the optimal solution.

4) Machine Learning:

Among the methods of artificial intelligence is machine learning. It entails managing, analyzing, and effectively learning from vast volumes of data. Numerous scientists with backgrounds in mathematics and software engineering want to solve issues and learn automatically from data using a variety of algorithms, which will help to increase performance effectively and efficiently (Mahesh, 2020).

Machine learning, on the other hand, is an analytical technique associated with artificial intelligence and technology that learns regularity standards, makes judgments from data, and makes predictions about unknown things based on it. Learning was the main emphasis of early machine learning research. But currently, learning-based prediction and judgment are the main focus (Seligman, 2018).

From this, **the researchers conclude** that "machine learning" is defined as the part related to automatic learning from available data without explicit programming or the need for an expert's assistance. The program then evaluates its performance and makes appropriate predictions and conclusions.

2.3 Concept of Internal Control:

Internal control is the organizational plan, methods, and procedures established by the organization to help achieve management objectives, ensure the soundness and efficiency of the organization's operations, apply management policies, and safeguard assets and properties

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from fraud and loss. It also aims to prevent and detect errors if they occur and ensure the accuracy and completeness of accounting records and the preparation of sound financial statements on time. It is considered one of the essential tools used by companies in general to monitor and control the tasks and operations they perform. Internal control seeks to implement the regulations and standards governing the work, which leads to a reduction in the level of risk and limits financial and administrative corruption. It is also regarded as a key component of the corporate governance system, especially concerning risk management (Raji et al., 2020).

The "Institute of Internal Auditors (IIA)" also defines the internal control system as the plans of the economic unit and all the methods and procedures taken by it to ensure the appropriateness and comprehensiveness of data, the protection of assets, and compliance with all policies and laws to achieve programs and activities economically. The "American Institute of Certified Public Accountants (AICPA)" defines the internal control system as an organizational plan and collection of procedures that the unit uses to safeguard its assets, guarantee the accuracy and dependability of its increase production efficiency, accounting data, and encourage adherence to management policies (Alqudah et al., 2024).

3. METHODOLOGY AND PROCEDURES

3.1 Study Methodology:

The descriptive-analytical approach was used in this study to thoroughly and methodically describe the study variables (internal control and artificial intelligence), as well as to determine their trends, relationships, and implications for the research problem. Finally, the study made relevant recommendations.

3.2 Study Population and Sample:

According to the 2023 Guide Bulletin of companies listed in the Amman Stock Exchange website, the population of the study comprised 46 Jordanian public shareholding industrial companies spread throughout 9 distinct industrial sectors. The key executives of the industrial firms that represented the study population were included in the study sample. A thorough survey method was used to establish the sample size, which came out to be 46 industrial businesses with public shares in Jordan.

3.3 Unit of Sampling and Analysis:

The study targeted employees in the finance, control and internal audit departments of Jordanian public shareholding industrial companies, specifically those holding positions such as Financial Manager, Head of Accounting Department, Internal Auditor, and Accountant. Due to the inability to obtain the exact number of these employees, and in order to obtain the largest possible number of targeted individuals, 230 questionnaires were distributed, with an average of 5 questionnaires per company.

The questionnaires were distributed and retrieved electronically, with 191 questionnaires returned, all of which were valid for analysis, resulting in a rate of response of 83.0%.

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3.4 Data Collection Source:

To gather the data and information required to meet its goals, the research turned to two sources:

3.4.1 First: Secondary Sources:

These include books, scientific research, reports from academic organizations, and articles from different websites. These sources were used to generate theoretical concepts on the study's subjects, investigate every facet and domain associated with its variables and dimensions, and make use of their resources in a manner that advances the goals of the investigation.

3.4.2 Second: Primary Sources:

This source consisted of a questionnaire created in a consistent manner with the study model's variables and by referring to secondary sources, aiming to collect information that reflects respondents' opinions about the study variables to understand and clarify the presumed relationship between the variables in the context of the study problem and its objectives.

The questionnaire included two sections, each containing several multiple-choice questions, as follows:

Part One: Demographic Data

This section consisted of a set of questions related to the sample respondents' demographic information, focusing on: years of experience, educational qualification, specialization, and job title

Part Two: Study Variables

The study included two main variables, which were measured through several items representing them. These items were divided as follows:

- **Independent Variable:** AI, measured through 20 items distributed across four sub-dimensions: expert systems, ANN, GA, and “machine learning”, with 5 items for each dimension.
- **Dependent Variable:** Internal Control, measured through 10 items.

The answer to each item represents the respondent's opinion about it, expressed using a 5-point Likert scale, which consists of five levels of agreement, each represented by a numerical value as follows (Sekaran, Bougie, 2016).

Table (1): Five-Point Likert Scale for Levels of Agreement and their Corresponding Numerical Values

Level of Agreement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Numerical Value	5	4	3	2	1

Based on the numerical values of the levels of agreement, the relative importance level of the items, variables, and dimensions was determined by relying on the mean value of the opinions, according to three levels, and by applying the following formula:

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$$\text{Interval Length}=\frac{\text{Number of Levels}\text{Upper Limit of the Alternative}-\text{Lower Limit of the Alternative}=\frac{1-5=1.33}{3}}{\text{Number of Levels}}$$

The following table illustrates the levels of relative importance and their ranges.

Table (2): Levels of Relative Importance and their Ranges

Level of Relative Importance	Low	Medium	High
Mean Value	1 - Less than 2.33	2.33 - Less than 3.66	3.66 – 5.00

3.4.3 Reliability Test of the Study Instrument

The purpose of the reliability test of the instrument of study is to measure the degree of its reliability and the consistency of the responses that can be derived from it when applied to the study population.

The Cronbach's Alpha Coefficient is considered one of the important measures in this field, with values ranging between 0 and 1. Cronbach's Alpha values that reach 0.70 or higher indicate reliability in the study instrument, and the degree of reliability increases as the coefficient value approaches 1 (Sekaran, Bougie, 2016).

The table below presents the results of the reliability test for the study instrument.

Table (3): Results of the Reliability Test for the Study Instrument

No	Variables	Cronbach's Alpha Coefficient
1	Expert Systems	0.876
2	Artificial Neural Networks	0.879
3	Genetic Algorithms	0.922
4	Machine Learning	0.830
5	Artificial Intelligence	0.938
6	Internal Control	0.903

All “Cronbach's Alpha” coefficient values are larger than 0.70, ranging between 0.830 and 0.938, making it clear from Table (3) that the study instrument has excellent reliability coefficients and the capacity to meet the study's goals.

3.4.4 Strength of the Correlation between Variables:

One statistical method for making sure that there are no issues with significant correlations between variables is the multiple linear correlation test. This test assesses how strongly the explanatory factors (independent variables) in the study model correlate with one another (Gujarati, 2004).

One popular test for determining how strongly explanatory variables is related to one another is the Pearson correlation coefficient. The research model's eligibility for parametric statistical techniques is confirmed by Pearson correlation coefficient values less than 0.80, which show that there is no multi collinearity issue (Gujarati, 2004). The results appeared as follows

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Table (4): Pearson Correlation Coefficients for the Explanatory Variables in the Study

Variable	Expert Systems	Artificial Neural Networks	Genetic Algorithms	Machine Learning
Expert Systems	1.000			
Artificial Neural Networks	0.624**	1.000		
Genetic Algorithms	0.632**	0.748**	1.000	
Machine Learning	0.348**	0.227**	0.319**	1.000

(**) At a significance level of 0.01

Referring to the values presented in Table (4), it is evident that there are no strong linear correlation relationships between the explanatory variables in the study, as all Pearson correlation coefficient values are less than 0.80, ranging between 0.227 and 0.748.

Other tests used to verify the presence of strong correlations between variables include a) the "Variance Inflation Factor (VIF)" and b) the Tolerance factor. VIF values ranging between 1.0 and 10.0, and Tolerance values ranging between 0.1 and 1.0, indicate the absence of a multi collinearity problem, thus confirming the suitability of the study model for parametric statistical methods. The results appeared as follows:

Table (5): Variance Inflation Factor (VIF) and Tolerance for Explanatory Variables in the Study

Variable	"Variance Inflation Factor (VIF)"	Tolerance
Expert Systems	1.911	0.523
Artificial Neural Networks	2.501	0.400
Genetic Algorithms	2.591	0.386
Machine Learning	1.168	0.856

It is clear from the numbers in Table (5) that the explanatory factors in the research do not have any significant correlations with one another. Both the VIF and tolerance values fall within the permitted ranges for each test, ranging from 1.168 to 2.591 and 0.386 to 0.856, respectively.

3.4.5 Statistical Methods Used:

Version 20 of the "Statistical Package for Social Sciences (SPSS)" was utilized to examine the study's data and evaluate its hypotheses. The statistical techniques listed below were used:

3.4.5.1 First: Descriptive Statistical Methods:

These techniques were employed to characterize the research sample's demographic or personal information, examine the responses to the items on the study instrument, and explain the study model's dimensions and variables. Among these techniques were standard deviation, mean, proportion, and frequency.

3.4.5.2 Second: Inferential Statistical Methods:

These methods were used to verify the reliability of the study instrument and the degree of correlation between the explanatory variables, as well as to test the hypotheses. These methods included the internal consistency coefficient (Cronbach's Alpha), Pearson correlation

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coefficient, Variance Inflation Factor (VIF), Tolerance factor, and multiple linear regression analysis.

3.4.6 Data Analysis and Hypothesis Testing:

3.4.6.1 Description of the Study Sample Characteristics:

This section presents the descriptive results obtained by analyzing the responses of the study sample on personal or demographic data. The descriptive statistical methods used in this study are frequencies and percentages.

Table (6): Description of Demographic Variables of the Targeted Employees in Industrial Companies

Variable	Category	Frequency	Percentage (%)
Years of Experience	Less than 5 years	12	6.3
	5 years - Less than 10 years	68	35.6
	10 years - Less than 15 years	80	41.9
	15 years or more	31	16.2
Educational Qualification	Bachelor's Degree	136	71.2
	Master's Degree	44	23.0
	PhD	11	5.8
Specialization	Accounting	113	59.2
	Accounting Information Systems	61	31.9
	Finance and Banking Sciences	10	5.2
	Business Administration	7	3.7
Job Title	Financial Manager	10	5.2
	Head of Accounting Department	16	8.4
	Internal Auditor	60	31.4
	Accountant	105	55.0
Total		191	100.0

Referring to the values presented in Table (6), it is evident that 41.9% of the study sample have experience ranging from 10 years to less than 15 years, 35.6% have experience from 5 years to less than 10 years, 16.2% have experience of 15 years or more, and 6.3% have experience of less than 5 years, which is the lowest percentage. This indicates that the employees possess practical skills that qualify them to perform their duties with high efficiency. It also shows that more than half of the sample (71.2%) hold a Bachelor's degree, and 28.8% hold higher academic qualifications (Master's and PhD), indicating a high educational level among the employees of industrial companies and their possession of the knowledge that qualifies them to perform their tasks as required.

What so more, it is evident that 59.2% of the sample are specialists in the field of accounting, and 31.9% are specialists in accounting information systems, which aligns with the nature of the targeted categories in the study, represented by employees in the finance and internal audit departments. Furthermore, 55.0% of the sample hold the position of Accountant, and 31.4% hold the position of Internal Auditor, while 8.4% hold the position of Head of the Accounting Department, and 5.2% hold the position of Financial Manager. This is consistent with the general distribution of employees in governmental and private companies and institutions,

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where the number of employees in lower administrative levels is higher compared to those in upper and middle administrative levels.

3.4.7 Analysis of Opinions on the Study Variables and their Description:

This section shows the descriptive results obtained by analyzing the opinions of the study sample on the study variables, indicating their level of importance and the extent of their application by industrial companies. The descriptive statistical methods used in this study include means, standard deviations, as well as relative importance and rank. The following table presents a general description of these variables and the dimensions designated to measure them in the industrial companies under study and their level of importance.

Table (7): Description of the Study Variables and their Dimensions in Industrial Companies

No.	Dimension	Mean	Standard Deviation	Rank	Relative Importance
1	Expert Systems	4.168	0.728	2	High
2	Artificial Neural Networks	4.073	0.714	3	High
3	Genetic Algorithms	3.832	0.919	4	High
4	Machine Learning	4.733	0.510	1	High
5	Artificial Intelligence	4.147	0.589	-	High
6	Internal Control	4.005	0.603	-	High

A closer inspection of the values presented in Table (7), With a mean of 4.147 and a standard deviation of 0.589, it is clear that artificial intelligence has a decisive role in industrial organizations. The mean values for the dimensions ranged between 3.832 and 4.733, all with high relative importance, and their standard deviations ranged between 0.510 and 0.919. This provides confirmation of the high level of interest in artificial intelligence and its dimensions in industrial companies. The "Machine Learning" dimension ranked first with a mean of 4.733 and a standard deviation of 0.510, followed by the "Expert Systems" dimension in the second place with a mean of 4.168 and a standard deviation of 0.728, then the "Artificial Neural Networks" dimension in the third place with a mean of 4.073 and a standard deviation of 0.714, and finally the "Genetic Algorithms" dimension in the fourth place with a mean of 3.832 and a standard deviation of 0.919.

It is also evident from Table (7) that with a mean of 4.005 and a standard deviation of 0.603, internal control is highly significant in industrial businesses.

3.4.8 Testing the Research Hypotheses

The main hypothesis states that the efficiency and effectiveness of internal control the industrial companies in Jordan are not statistically impacted by artificial intelligence in its different dimensions (“ANN, GA, expert systems, and machine learning”) at the level of significance ($\alpha \leq 0.05$).

In order to test this hypothesis and its sub-hypotheses, multiple linear regression analysis was used, and the results were as follows:

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Table (8): Results of Testing the "Main Hypothesis and Its Sub-Hypotheses"

Dependent Variable	Independent Variables	Coefficients Table			
		B	Standard Error	Calculated T	Sig t*
Efficiency and Effectiveness of Internal Control	Expert Systems	0.228	0.058	3.931	0.000
	Artificial Neural Networks	0.312	0.094	3.319	0.000
	Genetic Algorithms	0.333	0.077	4.325	0.000
	Machine Learning	0.199	0.068	2.926	0.001
Correlation Coefficient R				0.752	
Coefficient of Determination R^2				0.566	
Calculated F Value				91.446	
Sig. F*				0.000	

* The effect is statistically significant at the level ($\alpha \leq 0.05$).

It is evident from Table (8) that the correlation coefficient (R=0.752) indicates the relationship between the independent variable and the dependent variable. The effect of the independent variable (artificial intelligence) on the dependent variable (efficiency and effectiveness of internal control) is a significant positive effect with statistical significance, as the calculated F value is (91.446), with a significance level (Sig=0.000), which is less than 0.05. The coefficient of determination (R^2=0.566) indicates that 55.6% of the variance in (efficiency and effectiveness of internal control) can be explained by the variance in the dimensions of (artificial intelligence) combined.

The coefficients table showed that the value of B for the dimension (expert systems) was (0.228), with a t-value of (3.931) and a significance level (Sig=0.000), which is less than 0.05, indicating that the effect of this dimension is significant. Based on this, we reject the first null sub-hypothesis and accept the alternative, which states: "**There is a significant statistically effect at the significance level ($\alpha \leq 0.05$) of expert systems on the efficiency and effectiveness of internal control in Jordanian industrial companies**".

The value of B for the dimension (Artificial Neural Networks) was (0.312), with a t-value of (3.319) and a significance level (Sig=0.000), which is less than 0.05, indicating that the effect of this dimension is significant. Based on this, we reject the first null sub-hypothesis and accept the alternative, which states: "**There is a significant statistically effect at the significance level ($\alpha \leq 0.05$) of Artificial Neural Networks on the efficiency and effectiveness of internal control in Jordanian industrial companies**".

The value of B for the dimension (Genetic Algorithms) was (0.333), with a t-value of (4.325) and a significance level (Sig=0.000), which is less than 0.05, indicating that the effect of this dimension is significant. Based on this, we reject the first null sub-hypothesis and accept the alternative, which states: "**There is a significant statistically effect at the significance level ($\alpha \leq 0.05$) of Genetic Algorithms on the efficiency and effectiveness of internal control in Jordanian industrial companies**".

The value of B for the dimension (Machine Learning) was (0.199), with a t-value of (2.926) and a significance level (Sig=0.000), which is less than 0.05, indicating that the effect of this

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dimension is significant. Based on this, we reject the first null sub-hypothesis and accept the alternative, which states: "**There is a statistically significant effect at the significance level (α≤0.05) of Machine Learning on the efficacy and effectiveness of internal control in industrial companies in Jordan**."

Based on the above, we reject the main null hypothesis and accept the alternative hypothesis, which states: "There is a statistically significant effect at the significance level (α≤0.05) of artificial intelligence in its dimensions (artificial neural networks, expert systems, genetic algorithms, and machine learning) on the efficiency and effectiveness of internal control in the industrial companies in Jordan."

4. FINDINGS AND RECOMMENDATIONS

4.1 Findings:

Based on the descriptive and analytical outputs of the study instrument and its data, the study reached the following findings:

1. Jordanian public shareholding industrial companies show a high level of interest in artificial intelligence and its technologies ("machine learning, expert systems, ANN, and GA, respectively"). This high level of interest in artificial intelligence and its technologies reflects the awareness of industrial companies of their importance in enhancing their competitive capabilities and achieving sustainability through investment in technology and innovation. It helps companies continuously improve and develop their products and services, enhance the efficiency of their operational and production processes, respond to market changes and customer needs, and make accurate and effective decisions, thereby enhancing their competitive abilities.
2. "Jordanian Public Shareholding Industrial Companies" also show a high level of interest in internal control. This high level of interest reflects their understanding of the importance of protecting the company's assets and ensuring the integrity of financial and administrative operations. The efficiency and effectiveness of internal control contribute to enhancing the confidence of investors and shareholders, achieving compliance with local and international laws and regulations, thereby reducing financial risks and improving the quality of financial reports. Moreover, this focus on internal control helps enhance the company's reputation and increases its competitiveness in the market.
3. In its different dimensions ("expert systems, ANN, GA, and machine learning"), AI affects the efficiency and effectiveness of internal control in the industrial companies in Jordan. The presence of this effect indicates the significant positive role that artificial intelligence plays in the effectiveness and efficiency of "Internal Control (IC)". AI and its technologies help in detecting abnormal patterns and predicting potential risks faster than traditional methods, as well as enhancing transparency and reducing human errors, which increases confidence in IC systems and improves the ability to make effective decisions based on accurate and reliable analyses.

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4. Expert systems positively affect the effectiveness and efficiency of IC in Jordanian industrial companies. This effect indicates the positive role that expert systems play in control processes and achieving efficiency and effectiveness. Expert systems rely on specialized rules and knowledge to provide accurate recommendations and decisions, which helps improve the ability to detect problems and fraud more quickly and accurately. They also contribute to providing continuous and reliable analyses, reducing reliance on human judgment, and increasing the accuracy of operations, leading to improved company performance, compliance, and enhanced IC effectiveness.
5. Artificial neural networks have a favorable impact on Jordanian industrial businesses' IC efficacy and efficiency. This outcome demonstrates the beneficial contribution artificial neural networks provide to enhancing IC procedures. In order to anticipate possible hazards and identify manipulation or mistakes, artificial neural networks analyze vast volumes of data and learn from historical trends. This improves the efficacy of IC by offering a sophisticated control system that is distinguished by precision and speed in identifying and evaluating issues, resulting in informed and prompt decisions that improve internal operations safety and boost investor trust in the business.
6. Genetic algorithms positively affect the efficiency and effectiveness of IC in Jordanian industrial companies. This effect indicates the positive role that genetic algorithms play in improving internal control. Genetic algorithms help analyze large amounts of financial and operational data effectively and develop models based on extracted data, contributing to accurate predictions and the precise identification, tracking, and analysis of expected risks, improving planning, internal procedures, and decision-making, thereby helping to develop more accurate and effective control strategies.
7. Machine learning positively affects the efficiency and effectiveness of IC in Jordanian industrial companies. This effect indicates the positive role that machine learning plays in developing more intelligent and adaptive control systems. Machine learning analyzes large amounts of data, automatically discovers and learns patterns, and predicts risks and identifies deviations faster, which helps improve the accuracy and effectiveness of IC processes.

4.2 Recommendations:

Based on the findings reached, the study provides the following recommendations:

1. To enable effective data assimilation and analysis, industrial companies should offer cutting-edge technical infrastructure that supports artificial intelligence applications, such as cloud computing and big data.
2. To ensure that workers are qualified to apply artificial intelligence tools and techniques and can do so efficiently, industrial businesses should provide specific training programs.
3. To guarantee process harmonization and get optimal outcomes, industrial enterprises ought to include artificial intelligence technology with their current IC systems.

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4. Since the data used in artificial intelligence processes serves as the foundation for both accurate forecasting and intelligent decision-making, industrial organizations should regularly check the data to verify its quality and correctness.
5. To enhance artificial intelligence applications and increase their usage in different IC aspects, industrial businesses should spend in research and development processes. This will increase the company's efficiency and response to possible changes and hazards.

Industrial businesses should regularly assess the influence of artificial intelligence technologies on IC and their efficacy. Then, depending on the evaluation's findings, they should make the required adjustments.

4.3 Conclusions:

The study examined the effect of AI in its different dimensions (expert systems, artificial neural networks, genetic algorithms, and machine learning) on the efficacy and effectiveness of IC in industrial companies in Jordan. The study population consisted of Jordanian public shareholding industrial companies, totaling 46 companies distributed across 9 different industrial sectors, according to the Guide Bulletin of listed companies in the Amman Stock Exchange website for 2023. The sample was determined using a comprehensive survey technique. It was found that artificial intelligence has an impact on the efficiency and effectiveness of IC in Jordanian industrial companies. Future studies should be conducted on the impact of artificial intelligence in maximizing profitability in Jordanian banks.

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