MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 35 Issue 2, 2025, Pages: 1338-1362

Measuring and evaluating multidimensional performance using the TOPSIS model based on the integration of the Balanced Scorecard and budgeting. (A case study of a sample of companies listed on the ISX)

Hamzah N. Aljumaili [1*] and Jamel Chouaibi [2]
[1]*University of Fallujah, Iraq* , *hamza.nahid.a@uofallujah.edu.iq*
[2]*University of Sfax, Tunisia, jamel.chouaibi@fsegs.usf.tn*

Received: 12/09/2025; Accepted: 22/11/2025; Published: 30/12/2025

Abstract

Purpose *–This study aims to evaluate the performance of companies using the topsis method based on the dimensions of the BSc and the estimated budget, and then explore the effect of integrating the Balanced Scorecard (BSC) and the budget on sustainable performance in the companies under study, while studying the role of the effectiveness of AIS as an intervening variable in this relationship..*

Design/Methodology *– The study relied on the topsis method to evaluate companies, while the study of the relationship between variables relied on the descriptive analytical method. Financial data for ten years, from 2014 to 2024, was used. Path analysis and structural equation modeling (SEM) were employed using AMOS software, with the Bootstrap method used to estimate direct and indirect effects. The study also used a structured questionnaire that was distributed to a selected sample of managers and accountants working in the selected companies.*

Results *– The study demonstrated that integrating the BSC with budgeting has a strong positive impact on sustainable performance (beta = 0.523). This impact is clearly evident in the Iraqi Carpet and Furniture Company's leading position with an efficiency index (Ci = 0.69) in the TOPSIS analysis. This result supports the company's ability to link budget resources to tangible strategic outputs. The weakness of AIS in companies with low indicators (0.14) hinders their ability to reach optimal solutions. Effective sustainable performance is not the product of isolated financial planning, but rather the result of a robust information infrastructure that acts as a "key intermediary" linking long-term goals to operational results.*

Practical Implications *– The study recommends that organizations systematically link strategic vision with financial execution and invest in the quality of their accounting information systems.*

Originality/Value *– This study offers an original contribution by presenting an "integrated model" rather than relying on individual tools, providing a comprehensive framework for managing sustainability through the alignment of strategic, operational, and technical planning.*

Keywords*: Balanced Scorecard; Budgeting; Sustainable Performance; Accounting Information Systems; Strategic Integration.*

1. introduction

Performance measurement systems have become essential tools for companies to navigate the complexities of the business environment and enhance their competitiveness. Effective performance evaluation contributes to translating strategies into desired outcomes and behaviors, monitoring progress, motivating employees, and taking timely corrective action (Agbanu et al., 2016: p. 138; Uyar, 2010: p. 210). Furthermore, implementing appropriate performance management systems ensures consistency between strategies and procedures, provided these systems are flexible and adaptable to environmental changes. This necessitates examining them at the level of individual metrics, the system as a whole, and its relationship to the organizational environment (Behery and Parakandi, 2014: p. 23).

Performance measurement has undergone a clear evolution from reliance on traditional financial indicators to the use of a combination of financial and non-financial metrics linked to organizational strategy, such as the Balanced Scorecard and Key Performance Indicators (KPIs). The application of these systems has increased over the past two decades (Franco, 2012: 79; Poureisa et al., 2013: p. 974). Budgeting has been one of the most important tools for planning, control, and performance evaluation, despite criticisms regarding its rigidity, centralization, and focus on short-term objectives and financial aspects at the expense of value creation (Otley, 1978: 123; Hansen and Van, 2003: 110). Conversely, some researchers have pointed to the effectiveness of post-event budgeting in analyzing performance and deviations and supporting the evaluation of management efficiency (Helmi and Tanju, 1980: 23).

The dashboard has emerged as a modern tool for supporting decision-making and monitoring performance at the strategic, tactical, and operational levels. However, it can suffer from limitations in providing detailed and personalized information, especially in turbulent industrial environments (Marian and Ion, 2010:153; Gröger et al., 2013:205). To overcome the shortcomings of traditional tools that focused excessively on financial indicators, the Balanced Scorecard was developed by Kaplan and Norton (1992) as an integrated framework combining financial and non-financial metrics. It provides a holistic view of organizational performance and has since evolved into a widely adopted integrated system for management and strategic planning (Agbanu et al., 2016:142).

Multiple studies have shown that integrating the Balanced Scorecard with budgeting contributes to aligning organizational goals with resources and improving budget planning and performance evaluation in both the private and public sectors (Sedosheva, 2011: 79; Lin and Yahalom, 2009: 453; Tang and Huang, 2024: 111). The literature also emphasizes the pivotal role of effective accounting information systems in supporting this integration, given the accurate and relevant information they provide, which contributes to improving operational performance and enhancing sustainable performance (Okour, 2016: 263).

In this context, this study aims to explore the impact of integrating budgeting and the Balanced Scorecard on enhancing sustainable performance, while examining the mediating role of the effectiveness of accounting information systems in this relationship. To achieve this objective, the study employs the TOPSIS multidimensional model to evaluate the performance of a sample of companies listed on the Iraq Stock Exchange, using the dimensions of the Balanced Scorecard and the Budget as evaluation criteria. This model allows for a comprehensive and integrated view of performance that reflects the complexities of the modern competitive environment, and contributes to delivering practical results that can support decision-makers in listed companies and enhance their orientation towards achieving sustainable performance.

2. Literature Review and Hypothesis Development

2.1. Performance Measurement Using TOPSIS

Multi-criteria analysis (MCDM) is an effective method for evaluating and ranking company performance based on a set of financial ratios and indicators. TOPSIS is one of the most widely used methods in the literature (Deng & Willis, 2000). Numerous studies have demonstrated the effectiveness of TOPSIS in evaluating company performance across various sectors, including airlines (Feng and Wang, 2000), publicly traded computer companies (Tien-Chin and Hsu, 2004), banks (Demirelli, 2010), manufacturing (Yalcin et al., 2012), and cement companies (Ertugrul and Karakasoglu, 2009).

These studies indicate that TOPSIS provides a comprehensive and comparable assessment of company performance when using multiple financial indicators.

H1: Most companies have a relative convergence to the ideal solution (Ci) that exceeds the average between the best and worst values for each evaluation dimension.

2.2. Balanced Scorecard and Sustainable Performance

The literature confirms that the Balanced Scorecard (BSC) is an integrated framework that links financial and non-financial metrics, making it an effective tool for supporting sustainable performance in its economic, environmental, and social dimensions. Multiple studies have demonstrated the positive impact of implementing the Balanced Scorecard on sustainable performance across various sectors (Rafiq et al., 2020; De Silva et al., 2021; Gohar, 2019; Abdelrazek, 2019; Fatima & Elbanna, 2023; Qarawi, 2020).

Other studies have shown that integrating sustainability dimensions into the Balanced Scorecard enhances competitiveness and improves long-term performance (Asiaei & Bontis, 2019; Dias-Sardinha & Reijnders, 2005).

H2: There is a statistically significant effect ($p < 0.05$) of the Balanced Scorecard on sustainable performance.

2.3. Balanced Scorecard, Accounting Information Systems, and Sustainable Performance

Studies have indicated that the effectiveness of the Balanced Scorecard depends largely on the quality and effectiveness of Accounting Information Systems (AIS), which provide accurate data that supports strategic decision-making and sustainability. Empirical evidence has demonstrated a positive relationship between the implementation of the Balanced Scorecard and the effectiveness of AIS, and this is reflected in sustainable performance (Huy & Phuc, 2020; Shayyal et al., 2022; Abdulle & Ahmed, 2023).

H3: There is a statistically significant effect at the ($p < 0.05$) level of significance for the Balanced Scorecard on sustainable performance through the mediation of the effectiveness of accounting information systems.

2.4. Budgeting and Sustainable Performance

The budget is one of the most important planning and control tools that contributes to resource allocation and the translation of strategic objectives into financial plans. With the increasing focus on sustainability, the literature has emphasized the need to integrate environmental and social dimensions into the budgeting process to achieve sustainable performance (UNDP, 2020; Dharmanto et al., 2023; Jones, 2024).

Studies have also shown that effective financial planning enhances organizational resilience and improves long-term performance (Greenwich School of Business and Finance, 2024).

H4: There is a statistically significant effect at the ($p < 0.05$) level of significance for the budget on sustainable performance.

2.5. Budgeting, Accounting Information Systems, and Sustainable Performance

The literature indicates that accounting information systems (AIS) serve as a link between budgeting and sustainable performance by improving data accuracy, enhancing control, and supporting resource allocation decisions (Sori, 2009; Turner & Copeland, 2020; Wang & Zhu, 2025). Studies also confirm that integrating AIS with budgeting enhances economic, environmental, and social performance (Dillard & Baudot, 2016; Lavorato et al., 2024).

H5: There is a statistically significant effect ($p < 0.05$) of budgeting on sustainable performance mediated by the effectiveness of accounting information systems.

2.6. Integration of Balanced Scorecard, Budgeting, and Accounting Information Systems

Studies show that the integration of the Balanced Scorecard and budgeting, supported by effective accounting information systems, contributes to a comprehensive view of performance and improved organizational sustainability (Lin & Yahalom, 2009; Hussein, 2022; Esmaili & Mohtasham, 2023; Huy & Phuc, 2020). Although studies directly addressing this integration are limited, the results indicate a clear positive impact on sustainable performance.

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ISSN: 1053-7899
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H6-1: There is a statistically significant positive impact of the integration of the Balanced Scorecard and budgeting on sustainable performance, mediated by the effectiveness of accounting information systems.

H6-2: There is an important positive effect of the integration between BSC and the estimated budget on the dimensions of sustainable performance mediated by the effectiveness of accounting information systems.

3. Research Methodology

This study aims to evaluate and classify the performance of companies listed on the Iraq Stock Exchange according to the dimensions of the Balanced Scorecard and the Budget using the TOPSIS model. It also examines the impact of integrating these two dimensions on sustainable performance through the effectiveness of accounting information systems. The methodology employs two approaches: a descriptive approach to diagnose the variables, define the sample characteristics, and evaluate performance, and a deductive approach to scientifically test the hypotheses. For data analysis, descriptive statistical methods, multiple linear regression, and structural equation modeling using AMOS software were used.

3.1. Study Instruments

To achieve the objectives, the study relied on the integration of primary and secondary data through:

- Financial Data: This data was obtained from the published annual reports of the listed companies to measure the Balanced Scorecard indicators and sustainable performance.
- TOPSIS Model: An analytical tool for comparing and ranking companies based on their proximity to the ideal solution in light of approved performance criteria.
- Questionnaire: The questionnaire used was based on the questionnaires from the studies by (Huy & Phuc, 2020) and (Mbothu ,2012) regarding the effectiveness of accounting information systems and the budget.

3.2. Description of research variables

The research includes a set of studied variables, which can be described and their dimensions as shown in Table (1):

Table 1. Description of research variables

Variable Name	Variable Dimensions	Data Type and Source
Balanced Scorecard (BSC)	1. Financial Perspective 2. Customer Perspective 3. Internal Processes Perspective 4. Learning and Growth Perspective	Financial data (Financial Statements)
Sustainable Performance	1. Economic Performance 2. Social Performance 3. Environmental Performance	Financial data (Financial Statements)
Accounting Information Systems	1. Input System 2. Data Processing 3. Outputs and Storage	Questionnaire (Huy & Phuc, 2020)
Estimated budget	1. Managers' Participation 2. Long-term Objectives 3. Resource Allocation 4. Continuous Improvement 5. Budget Preparation Complexity	Questionnaire (Mbothu, 2012)
Integration of Tools (BSC+Budgeting)	Average of Balanced Scorecard and Budgeting System	Computed Variable (Data Integration)

The theoretical relationship between the studied variables can be represented according to Figure (1). This serves as the procedural plan for the study, which was followed to achieve results that fulfill the study's objectives and answer its questions.

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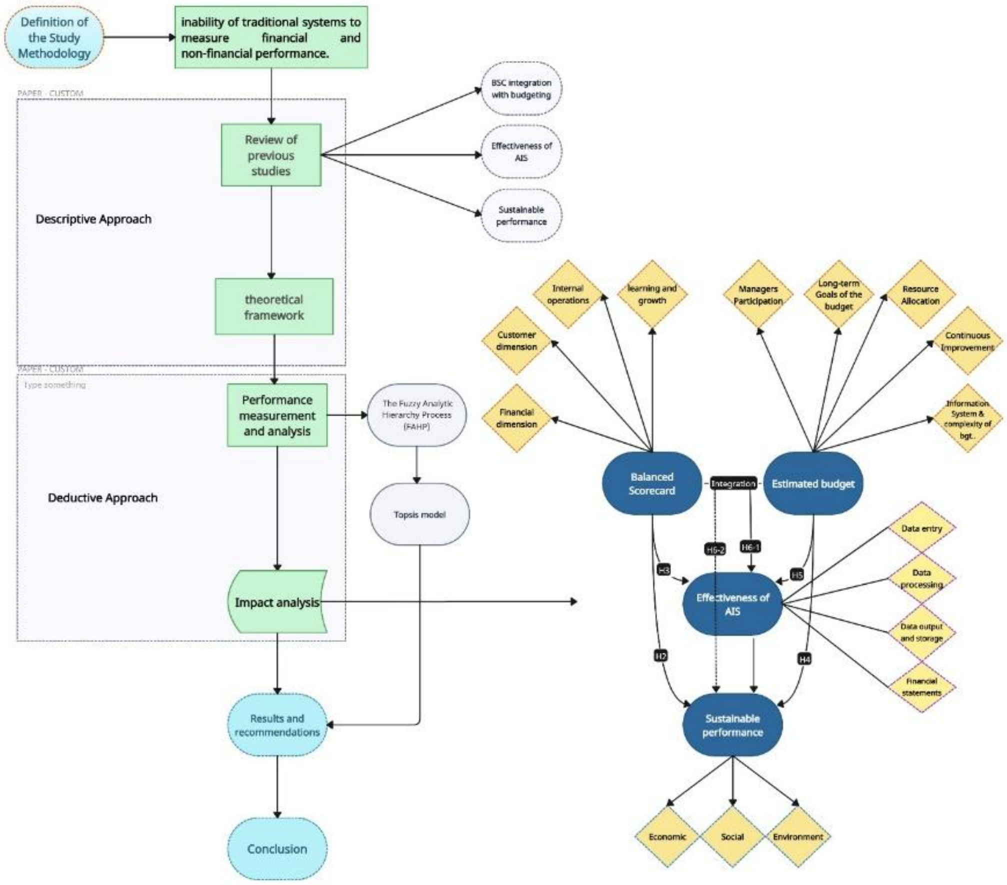

Figure 1. The theoretical relationship between the studied variables

3.3. Sample Preparation

The research sample consisted of 15 companies listed on the Iraq Stock Exchange, representing diverse industrial, service, and agricultural sectors, such as food processing, chemicals, pharmaceuticals, textiles, agriculture, telecommunications, and engineering. This sample was selected to provide a realistic and diverse representation of the nature of listed Iraqi companies, thus enhancing the generalizability of the study's findings. Table (2) lists the selected companies.

Table 2. lists the selected companies.

no	NAME	CODE	Capital
1	Modern Company for Animal and Agricultural Production	AMAP	20,506,500,000
2	Modern Sewing Company	IMOS	2,000,000,000
3	National Company for Metal Industries and Bicycles	IMIB	5,000,000,000
4	Modern Chemical Industries	IMCL	180,000,000
5	Iraqi Company for Carpets and Furnishings	IITC	500,000,000
6	Iraqi Company for Engineering Works	IIEW	1,500,000,000
7	Al-Kindi Company for the Production of Vaccines and Veterinary Medicines	IKLV	5940000000
8	Baghdad Company for Soft Drinks	IBSD	2.04335E+11
9	Iraqi Company for the Manufacturing and Marketing of Dates	IIDP	17,250,000,000
10	Al-Mansour Company for Pharmaceutical Industries, Medical Supplies, Cosmetics, and Sterile Water	IMAP	18,560,000,000

11	Ready-Made Garments Production and General Trading	IRMC	3,186,600,000
12	Baghdad Company for Packaging Materials	IBPM	1,080,000,000
13	Asia Cell for Communications	TASC	310000000000
14	Iraqi Company for the Production and Marketing of Meat and Field Crops	AIPM	5,000,000,000
15	Iraqi Company for the Production and Marketing of Agricultural Products	AIRP	360000000

3.4. Data Collection and Period

Data related to the Balanced Scorecard and Sustainable Performance variables were collected from the financial reports of the companies studied. These reports were obtained from the Securities Commission and are available at the following link: (https://www.isc.gov.iq). Financial data was collected for the period from 2014 to 2024. As for the variables of estimated budget and the effectiveness of accounting information systems, questionnaires were used. We relied on the studies of (Huy & Phuc, 2020 & Mbothu, 2012) in preparing these questionnaires. Twenty individuals from each company were targeted at answering the items repeatedly and according to the corresponding years of the financial data. The total number of responses was 3300, which were valid for statistical analysis. Regarding the weighting of company evaluation criteria, we relied on the response of an expert from the Iraq Stock Exchange to the verbal evaluation form, which forms the basis of the Fuzzy Hierarchical Analysis Process (FAHP) for Multi-Criteria Decision Making (MADM). This process determines the weighting of criteria used for evaluation using fuzzy rules. Based on these fuzzy rules, a decision matrix is constructed. Its elements contain performance metrics for one decision problem compared to another, which will serve as the first step in analyzing and classifying company performance according to the Topsis methodology.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistical Analysis

The descriptive statistical analysis aims to provide a preliminary overview of the study data characteristics through measures of central tendency and dispersion. This helps in understanding the level of availability of the study dimensions in the companies included in the study before proceeding to inferential analysis.

The following indicators were used: minimum, maximum, arithmetic mean, and standard deviation for each of the following dimensions: Balanced Scorecard, Budgeting, and Accounting Information Systems Effectiveness. See Table 3.

Table 3: Descriptive Statistical Analysis of the Study Variables

Variable	Mean Range	Interpretation of Results
Financial Perspective	Mixed (positive and negative values)	Clear variation in financial performance among companies
Customer Perspective	Mostly low means	Relative weakness in focusing on customer satisfaction
Internal Processes	High variation	Differences in operational efficiency
Learning and Growth	Significant variation	Differences in investment in human capital
Effectiveness of Accounting Information Systems	(3.12 – 4.40)	Moderate to high level
Budgeting System	(2.94 – 3.64)	Moderate level of implementation

The results indicate a significant variation in performance levels among companies, particularly in non-financial dimensions. Budgeting and accounting information systems showed moderate to high levels of implementation, justifying further investigation into their relationship with sustainable performance.

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4.2. Correlation Analysis

Pearson's correlation coefficient was used to measure the nature and strength of the relationship between the main variables of the study at significance levels of 0.01 and 0.05. See Table 3

Table 4.Correlation Matrix between Main Variables

Variables	Budgeting	AIS	Balanced Scorecard	Sustainable Performance
Budgeting	1	0.747**	0.080	0.219**
AIS	0.747**	1	0.169*	0.109
Balanced Scorecard	0.080	0.169*	1	0.332**
Sustainable Performance	0.219**	0.109	0.332**	1

Significant at 0.01 – (*) Significant at 0.05

Statistical analysis revealed a strong, statistically significant positive relationship ($p < 0.01$) between budgeting and information systems, with a correlation coefficient of $r = 0.747$. This indicates that the efficiency of information systems contributes significantly to the effectiveness of budget preparation and implementation. Conversely, the results showed a weak and statistically insignificant relationship between budgeting and the Balanced Scorecard, reflecting the limited direct impact of budgeting on the application of the Balanced Scorecard dimensions in the study sample. The results also revealed a statistically significant positive relationship ($p < 0.05$) between budgeting and sustainable performance, demonstrating the role of budgeting in supporting sustainable performance. Furthermore, the results showed a moderate positive relationship between the Balanced Scorecard and sustainable performance, confirming the importance of the Balanced Scorecard as a management tool that contributes to improving sustainable performance. Regarding information systems, no statistically significant direct relationship was found between them and sustainable performance, supporting the use of information systems as a mediating variable in the relationship between budgeting and sustainable performance.

4.3. Data Validity Testing Before SEM

4.3.1. Normality Test

The normality of the distribution was verified using skewness and kurtosis coefficients.

Table 5. Normality Test Results

Variable	Skewness	Kurtosis	Decision
Balanced Scorecard – Financial Perspective	-1.162	2.268	Acceptable
Balanced Scorecard – Customer Perspective	1.898	3.326	Acceptable
Balanced Scorecard – Internal Processes Perspective	1.853	4.732	Acceptable
Balanced Scorecard – Learning and Growth Perspective	1.364	3.387	Acceptable
Budgeting System – Managers' Participation	-1.015	2.073	Acceptable
Budgeting System – Long-term Objectives	-0.858	1.257	Acceptable
Budgeting System – Resource Allocation	-0.632	0.373	Acceptable
Budgeting System – Continuous Improvement	-0.651	0.197	Acceptable
Budgeting System – Information Systems	-0.609	0.946	Acceptable
Effectiveness of Accounting Information Systems	-0.164	3.777	Acceptable
Sustainable Performance	-1.492	4.083	Acceptable

Table (**5**) shows that all study variables had skewness and kurtosis values within statistically acceptable limits, indicating that the data follow an acceptable normal distribution. Therefore, the study data are suitable for use in parametric statistical tests without any issues related to distributional skewness.

4.3.2 Multiple Linear Correlation (VIF) Test and Confirmatory Factor Analysis (CFA)

The results of the Multiple Linear Correlation (VIF) test show that the values of the coefficient of inflation of variance for all study variables ranged from 1.003 to 2.932, which is within statistically acceptable limits. This indicates the absence of multicollinearity among the independent variables and confirms the soundness of the structural model in terms of variable independence and its ability to provide accurate statistical interpretation.

Similarly, the results of the Confirmatory Factor Analysis (CFA) demonstrated that the measurement model has a high degree of fit. The conformance indices (CMIN/DF, GFI, CFI, TLI, RMSEA) were all within the good and excellent ranges, reflecting strong agreement between the actual data and the proposed theoretical model. Therefore, the measurement model can be relied upon with high statistical confidence to test structural relationships and research hypotheses. (See table 6)

Table 6. results (VIF) and (CFA)

Location	Test/Indicator	Value	Statistical standard	The ruling
Multicollinearity	VIF	1.003 – 2.932	≤5	no multicollinearity
Confirmatory factor Analysis	CMIN/DF	2.15	≤ 3	good
	GFI	0.92	≥ 0.90	good
	CFI	0.95	≥ 0.90	excellent
	TLI	0.94	≥ 0.90	excellent
	RMSEA	0.045	≤ 0.08	excellent

4.3.3 Convergent Validity

The results in Table (7) demonstrate convergent validity, as the AVE and cr values exceeded acceptable limits. Discriminatory validity was also confirmed according to the HTMT criterion, indicating conceptual differentiation of the variables and the absence of overlap between them. Furthermore, the internal reliability results confirmed high levels of consistency and reliability of the measurement instruments. Therefore, the study instruments are statistically sound and support the validity of the theoretical model, justifying the confident transition to structural model testing and the study hypotheses using SEM via AMOS. (see Table 7)

Table 7. results CR and AVE

Test type	Statistical indicator	Calculated values	standard	The ruling
Convergent Validity	AVE	> 0.50	≥ 0.50	Verified
	CR	> 0.70	≥ 0.70	Verified
Discriminant Validity	HTMT	< 0.85	≤ 0.85	acceptable
Internal Consistency	CR	> 0.79	≥ 0.70	high
	Cronbach's Alpha	> 0.77	≥ 0.70	high

5. Results

5.1. Fuzzy Analytical Hierarchy Process (FAHP)

Fuzzy Analytical Hierarchy Process (FAHP) is a multi-criteria decision-making (MADM) technique that uses fuzzy numbers to determine the weights of criteria within a decision matrix, enabling more flexible and accurate comparisons of performance elements (Varshney, 2024). FAHP is suitable for self-assessments and is widely used in business, management, manufacturing, industry, and government.

FAHP was first proposed by Van Laarhoven and Peedrycz (1983) using trigonometric fuzzy numbers (TFNs) in pairwise comparisons and has since evolved to include other types such as trapezoidal or Gaussian membership functions. In recent years, FAHP has been widely applied in evaluation and selection, often in conjunction with other methods (Emrouznejad & Ho, 2017). Fuzzy logic extends traditional Boolean logic to deal with uncertainty, and offers more realistic and flexible solutions compared to techniques based on classical logic (Badawi et al., 2019).

8.1.1 Steps for Implementing FAHP

The AHP scale relies on hierarchically dividing the problem. The problem with the traditional AHP method lies in its use of precise values to express the decision-maker's opinion in a pairwise comparison between alternatives (Volaric, 2014: 227). Chang (1996) presented a new approach to dealing with the FAHP scale, using triangular fuzzy numbers for the pairwise comparison scale and employing range analysis for the synthetic range values of the pairwise comparisons (Chang, 1996: 649).

First: Fuzzy Numbers

Definition 1: Let M ∈ F(R). It is called a fuzzy number if the following two conditions are met:

(1) There exists $x0 \in R$ such that $\mu M\ (x0) = 1$

(2) For any $0 \leq \alpha \leq 1$, $A\alpha = [x,\ \mu A\alpha\ (x) \geq \alpha]$ is a closed interval.

Where F(R) represents a family of all fuzzy sets and R is the set of real numbers.

Definition 2: A fuzzy number (M) on R is said to be a triangular fuzzy number if its membership function $\mu\mathrm{M}(x)$: $R \rightarrow [0,1]$ is defined as follows:

Different fuzzy numbers can be used depending on the situation. In general, triangular and trapezoidal fuzzy numbers are commonly used. In applications, triangular fuzzy numbers (TFNs) are often convenient to work with due to their computational simplicity and their usefulness in enhancing representation and information processing in fuzzy environments. In this study, triangular fuzzy numbers were adopted in FAHP.

Trigonometric fuzzy numbers can be expressed by the formula (l, m, u). The coefficients m, l, and u, respectively, represent the smallest possible value, the most promising value, and the largest possible value to describe a fuzzy event. The triangular fuzzy number M is shown in Figure 2 (Ding, 1999).

There are various operations on triangular fuzzy numbers. However, three important operations used in this study are illustrated here. If we define two positive triangular fuzzy numbers (l_1, m_1, u_1) and (l_2, m_2, u_2), then:

$$(l_1, m_1, u_1) + (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \qquad (1)$$

$$(l_1, m_1, u_1) \cdot (l_2, m_2, u_2) = (l_1 \cdot l_2, m_1 \cdot m_2, u_1 \cdot u_2) \qquad (2)$$

[illegible] (3)

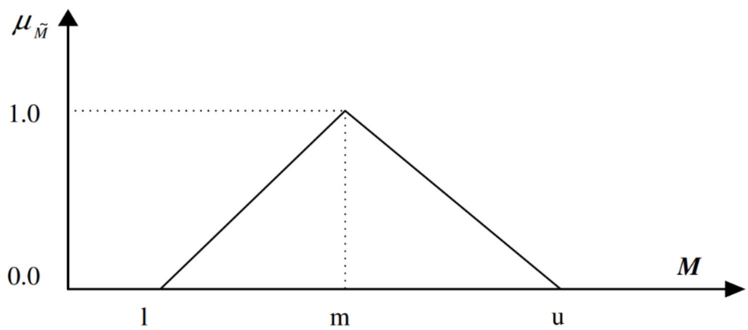

Figure 2. The three-dimensional fuzzy number

In our study, we used the FAHP range analysis algorithm, introduced by Chang (1996). Suppose:

A set of elements... X = {x1, x2, x3, ..., xn}

A set of targets... G = {g1, g2, g3, ..., gn}

According to Chang's range analysis method, each element is taken and a range analysis is performed for each target individually.

Thus, m can be obtained from the range analysis values for each element, using the following signals:

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ISSN: 1053-7899
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$$M_{gi}^1, M_{gi}^2, \ldots, M_{gi}^m, \quad i = 1, 2, \ldots, n, \qquad (4)$$

where are triangular fuzzy numbers (TFNs).

Chang's range analysis of the AHP fuzzy algorithm relies on the probability of each criterion. First, triangular fuzzy numbers are considered when using the pairwise comparison metric of the AHP fuzzy algorithm. Then, the following steps of Chang's analysis are used to complete the entire procedure.

Step 1: The artificial fuzzy range value for object i is defined as:

$$S_i = \sum_{j=1}^{m} M_{gi}^j \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j \right]^{-1} \qquad (5)$$

To obtain $\Sigma_{j=1}^{m} M_{gi}^j$, fuzzy summation is performed on the range analysis values of the elements of a given matrix, as follows:

$$\sum_{j=1}^{m} M_{gi}^j = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right) \qquad (6)$$

To obtain $\left[\sum_{j=1}^{n} \sum_{j=1}^{m} M_{gi}^j \right]^{-1}$, fuzzy summation of values is performed using:

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i \right) \qquad (7)$$

The inverse of the vector above is then calculated, as shown below:

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i} \right) \qquad (8)$$

Since $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ are triangular fuzzy numbers, the probability degree of $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ is defined as follows:

$$V(M_2 \geqslant M_1) = \sup \left[\min\left(\mu_{M_1}(x), \mu_{M_2}(y)\right) \right] \qquad (9)$$

$$V(M_2 \geqslant M_1) = hgt(M_1 \cap M_2) = \mu_{M_2}(d) \qquad (10)$$

$$= \begin{cases} 1 & \text{if } m_2 \geqslant m_1 \\ 0 & \text{if } l_1 \geqslant u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & \text{otherwise} \end{cases} \qquad (11)$$

Figure (3) (Chang, 1996) illustrates equation (10), where d represents the vertical coordinate of the highest point of intersection D between M1μ and M2μ; to compare M1 and M2, we need both values V(M1≥M2) and V(M2≥M1)

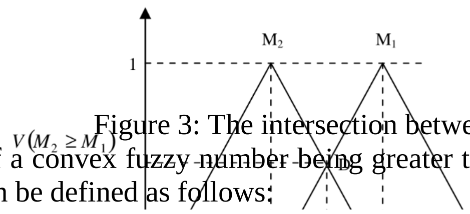

Figure 3: The intersection between M1 and M2

Step three: The probability of a convex fuzzy number being greater than K can be defined as (i=1, 2, ..., K)Mi, and the numbers can be defined as follows:

$$V(M \geqslant M_1, M_2, \ldots, M_k) = V[(M \geqslant M_1) \text{ and } (M \geqslant M_2) \text{ and } \cdots \text{ and } (M \geqslant M_k)]$$
$$= \min V(M \geqslant M_i); \quad i = 1, 2, 3, \ldots, k \qquad (12)$$

Assume that V(Si ≥ Sk) d(Ai) for K = 1, 2, ..., n; K ≠ i. Then the weight vector is given by:

$$W' = \left(d'(A_1), d'(A_2), \ldots, d'(A_n)\right)^{\mathrm{T}} \qquad (13)$$

Where Ai(i=1,2,...,n) are the elements.

Step 4: Through the normalization process, the normalized weight vectors are as follows:

$$W = \left(d(A_1), d(A_2), \ldots, d(A_n)\right)^{\mathrm{T}} \qquad (14)$$

Where W is a non-fuzzy number.

5.2. Procedural Outcomes of Applying the FAHP Methodology

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ISSN: 1053-7899
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Applying the Fuzzy Hierarchy Analysis (FAHP) methodology to determine the relative importance of performance criteria requires several interconnected steps to ensure the accuracy and consistency of the analysis. These steps can be summarized as follows:

5.2.1. Defining the Hierarchical Model Structure

The model is built on three main levels: the overall objective (determining the relative importance of performance dimensions), the criteria (the five main dimensions), and the pairwise relationships between these criteria.

5.2.2. Developing the Fuzzy Pairwise Comparison Matrix:

Expert opinions are gathered through questionnaires, and the linguistic assessments are converted into fuzzy triangular numbers representing the degree of preference for each dimension over the others.(see Table 8)

Table 8. Pairwise Comparison Matrix

Criteria	F	BGT	C	I	L
F	(1,1,1)	(1/3,1/2,1)	(1,1,1)	(2,3,4)	(3,4,5)
BGT	(1,2,3)	(1,1,1)	(1,2,3)	(2,3,4)	(1,2,3)
C	(1,1,1)	(1/3,1/2,1)	(1,1,1)	(3,4,5)	(1,2,3)
I	(1/4,1/3,1/2)	(1/4,1/3,1/2)	(1/5,1/4,1/3)	(1,1,1)	(1,2,3)
L	(1/5,1/4,1/3)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1,1,1)

Step 1: Calculating the values of the fuzzy artificial range (Si)

1- Calculating the sum of rows $\boldsymbol{\Sigma_{j=1}^{m} M_g^j}$

F:(1 + 0.33 + 1 + 2 + 3,1 + 0.5 + 1 + 3 + 4,1 + 1 + 1 + 4 + 5) = (7.33,9.5,12.0)
BGT:(1 + 1 + 1 + 2 + 1,2 + 1 + 2 + 3 + 2,3 + 1 + 3 + 4 + 3) = (6.0,10.0,14.0)
C:(1 + 0.33 + 1 + 3 + 1,1 + 0.5 + 1 + 4 + 2,1 + 1 + 1 + 5 + 3) = (6.33,8.5,11.0)
I:(0.25 + 0.25 + 0.2 + 1 + 1,0.33 + 0.33 + 0.25 + 1 + 2,0.5 + 0.5 + 0.33 + 1 + 3) = (2.7,3.91 , 5.33)
L:(0.2 + 0.33 + 0.33 + 0.33 + 1,0.25 + 0.5 + 0.5 + 0.5 + 1,0.33 + 1 + 1 + 1 + 1) = (2.19, 2.75,4.33)

2- Calculating the total sum and its inverse $\left(\sum\sum m_{g_i}^j\right)^{-1}$

The total sum is the sum of all the row sum vectors you previously calculated for each dimension (F, BGT, C, I, L), element by element. $\sum\sum m_{g_i}^j = \left(\sum u \sum m_i \Sigma_{l_i}\right)$, resulting in: (24.55, 34.66, 46.66)

The inverse (reversing the order): (0.0407, 0.0288, 0.0214) = $\frac{1}{46.66}, \frac{1}{34.66}, \frac{1}{24.55}$

3- Calculating the values of (s_i) (multiplying the sum of each row by its inverse)

S_F = (7.33, 9.5, 12.0) ⊗ (0.0214, 0.0288, 0.0407) = (0.157, 0.274, 0.488)
S_{BGT} = (6.0, 10.0, 14.0) ⊗ (0.0214, 0.0288, 0.0407) = (0.128, 0.288, 0.570)
S_C = (6.33, 8.5, 11.0) ⊗ (0.0214, 0.0288, 0.0407) = (0.135, 0.245, 0.448)
S_I = (2.7, 3.91, 5.33) ⊗ (0.0214, 0.0288, 0.0407) = (0.057, 0.112, 0.217)
S_L = (2.19, 2.75, 4.33) ⊗ (0.0214, 0.0288, 0.0407) = (0.046, 0.079, 0.176)

Steps 2 and 3: Calculating the probability score $v(s_i \geq s_k)$

Using equation (10) in our methodology, we calculate the probability score for each (s_i) to be greater than the others.

Note: If mi ≥ mk, the score is 1. If not, we apply the intersection equation (d)

1- Representing the Synthetic Extent value for each criterion i as a triangular fuzzy number on the image

$$s_i = (u, m_i, l_i)$$

Where represents the minimum, (m_i) the middle value, and (u_i) the maximum.

2- Compare the middle values (m_i) of all criteria to determine the dominant criterion, as the criterion with the highest middle value is initially preferred. Since:

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$$m_{BGT}=0.288$$

If it is the highest among the criteria, its probability level is:

$$d(BGT)=1.00$$

If the condition is met:

$$m_i \geq m_k$$

The probability degree is given directly as a value.

$$V(S_i \geq S_k) = 1$$

3- If the previous condition is not met, and the null condition $l_k \geq u_i$ is not met, the probability score is calculated using the intersection equation according to Chang's (1996) method:

$$V(S_i \geq S_k) = \frac{u_i - l_k}{(u_i - m_i) + (m_k - l_k)}$$

4- By applying the intersection equation to compare the F criterion with the BGT criterion:

$$V(S_F \geq S_{BGT}) \approx 0.96$$

Therefore, it should be:

$$d(F) = 0.96$$

5- In the same way, the probability scores for the remaining criteria are calculated, with the smallest resulting value being chosen from comparison with the other criteria:

$$d(C) \approx 0.89$$
$$d(I) \approx 0.38$$
$$d(L) \approx 0.19$$

6-Finally, the probability scores for each criterion are summed to form the abnormalized weight vector:

$$W' = (d_F, d_{BGT}, d_C, d_I, d_L)$$
$$\boxed{W' = (0.96, 1.00, 0.89, 0.38, 0.19)}$$

Step 4: Normalization

We divide each value by the vector sum (0.96 + 1.00 + 0.89 + 0.38 + 0.19 = 3.42) to obtain the final non-fuzzy weights W: (see table 9)

Table 9. Normalization

Criteria	Applied weight (W)	%	Ranking
BGT	0.292	29.2%	First
F	0.281	28.1%	Second
C	0.260	26.0%	Third
I	0.111	11.1%	Fourth
L	0.056	5.6%	Fifth

5.2.TOPSIS Method

The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method is a numerical multi-criteria decision-making (MCDM) technique that relies on selecting the alternative closest to the positive ideal solution and furthest from the negative ideal solution. The positive ideal solution combines the best possible values for the criteria, while the negative ideal solution combines the worst values. TOPSIS is characterized by its simplicity and effectiveness, and it can be computer-aided for a wide range of practical applications, including performance evaluation, supplier selection, project design, and risk assessment. It can also be extended to fuzzy environments to assign relative importance to attributes using fuzzy numbers instead of precise figures, making it suitable for group decision-making in uncertain situations. Its applications are broad in management and engineering fields, such as strategic site selection, bridge and industrial project evaluation, and robot and prototype selection.

5.2.1.The TOPSIS Method Steps

The fuzzy TOPSIS method is an extension of the traditional TOPSIS method. It addresses the inherent ambiguity and uncertainty in decision-making problems by using fuzzy numbers to represent the weights of criteria and alternative evaluations. The following are the detailed steps:

Step 1: The TOPSIS method assumes that the decision matrix D includes m alternatives and n criteria as follows:

$$
D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array}
\begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\
\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array}
$$

Step 2: Normalizing the Decision Matrix

The decision matrix is normalized using vector normalization as described below:

$$
r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^{2}}}, \quad i = 1,\dots,m;\ j = 1,\dots,n
$$

This leads to a standardized decision matrix as follows:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}_{m\times n}$$

Step 3: The standard weighted decision matrix is constructed as follows:

$$v_{ij} = w_i * r_{ij},\ i = 1,\ldots,m;\ j = 1,\ldots,n\ .$$

Step 4: The PIS (positive ideal solution) and NIS (negative ideal solution) are determined, respectively:

$$A^* = \left(v_1^*, v_2^*, \ldots, v_j^*, \ldots, v_n^*\right) \quad \textit{maximum values,}$$

$$A^- = \left(v_1^-, v_2^-, \ldots, v_j^-, \ldots, v_n^-\right) \quad \textit{minimum values}$$

Step 5: The distance of each alternative from the PIS and NIS is calculated as follows:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^+\right)^2}, i = 1,2,\ldots,m$$

$$d_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2},\quad i = 1,2,\ldots,m$$

Step 6: The proximity coefficient for each alternative (CCi) is calculated as follows:

$$CC_i = \frac{d_i^-}{d_i^* + d_i^-}$$

Step 7: The ranking of alternatives is determined by comparing CCi values.

5.2.2.Procedural Results of Applying the TOPSIS Method

Phase 1: Evaluating Company Performance Using the TOPSIS Model

Table (10) represents the initial data for evaluating fifteen companies across five key dimensions: financial, customer, internal processes, learning and growth, and budget. Each dimension has a specific weight reflecting its importance in the decision-making process, derived from the FAHP method. The financial dimension has a weight of 0.281, while the other dimensions have relatively lower weights, indicating that financial performance has a greater impact on the final company evaluation. The initial values for each company show its raw performance in each dimension, but they are not directly comparable due to the different metrics. For example, the budget value is significantly higher than the values for the customer or internal processes dimensions, necessitating subsequent normalization. This table serves as the starting point for applying the TOPSIS model and reflects the variation in company performance across the different dimensions.

Table 10. Preliminary data for evaluating fifteen companies across key dimensions

Weight	0.281	0.26	0.111	0.056	0.292
criteria	F	C	I	L	BGT
AMAP	0.06756	0.14796	0.48261	0.14909	3.4545
IMOS	0.24489	0.01449	0.03208	0.16104	3.1236

IMIB	0.48675	0.16576	0.32752	0.32562	2.9855
IMCL	0.23390	0.14863	0.32106	1.401931	3.2727
IITC	0.22744	1.44897	0.21461	0.159413	3.4182
IIEW	0.09209	0.18484	0.05874	0.165790	3.1719
IKLV	0.08269	0.06684	0.06644	0.161791	3.1418
IBSD	0.10785	0.13565	0.82332	0.15924	3.4509
IIDP	0.00389	0.08645	0.31893	0.15841	3.1127
IMAP	0.44933	0.14654	0.30620	0.09896	3.5164
IRMC	0.06418	0.10575	2.50831	0.15938	3.64
IBPM	0.03127	0.15352	0.41327	0.161791	3.6109
TASC	0.10747	0.15044	0.19403	0.103084	3.5236
AIPM	0.17315	0.12634	0.44468	0.158496	2.9382
AIRP	0.11536	0.11736	0.35645	0.160587	3.1443
total	0.69672	2.34431	8.19648	2.37204	164.116

The initial values for each company were converted to a standardized range of 0 to 1, making comparisons between different dimensions possible and objective. For example, companies with a high budget were reduced in influence compared to others to avoid distorting the results. The normalized matrix reveals companies that excel in specific dimensions; for instance, Iraqi Carpets and Furnishings excels in the customer dimension (0.946) while remaining relatively weak in other dimensions. Normalization ensures that each dimension has a proportional impact, and the results are not affected by the absolute values of different dimensions.(see table 11)

Table 11. Calculate Normalized Matrix

companies	F	C	I	L	BGT
AMAP	0.081	0.097	0.169	0.097	0.270
IMOS	0.293	0.009	0.011	0.105	0.244
IMIB	0.583	0.108	0.114	0.211	0.233
IMCL	0.280	0.097	0.112	0.910	0.255
IITC	0.272	0.946	0.075	0.104	0.267
IIEW	0.110	0.121	0.021	0.108	0.248
IKLV	0.099	0.044	0.023	0.105	0.245
IBSD	0.129	0.089	0.288	0.103	0.269
IIDP	0.005	0.056	0.111	0.103	0.243
IMAP	0.538	0.096	0.107	0.064	0.274
IRMC	0.077	0.069	0.876	0.103	0.284
IBPM	0.037	0.100	0.144	0.105	0.282
TASC	0.129	0.098	0.068	0.067	0.275
AIPM	0.207	0.083	0.155	0.103	0.229
AIRP	0.138	0.077	0.125	0.104	0.245

In Table (12), each printing value was multiplied by the weight of its corresponding dimension, reflecting the actual impact of each dimension on the overall performance of each company. The columns S^+ and S^- represent the distance from the positive and negative optimum, respectively, while the performance index (Ci) represents how close the company is to the optimum. The table clearly shows that some companies, such as the Iraqi Carpet and Furniture Company, achieved the highest Ci value (0.69), indicating their proximity to the optimum, while companies like the National Metal Industries and Bicycle Company obtained the lowest Ci value (0.14), indicating their distance from the optimum. This table provides a scientific basis for classifying companies according to their performance..

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Table 12. Weighted Normalized Matrix

companies	F	C	I	L	BGT	S-	S+	Perfo Score (Ci)	Rank
AMAP	0.023	0.025	0.019	0.005	0.079	0.170	0.248	0.41	5
IMOS	0.082	0.002	0.001	0.006	0.071	0.093	0.274	0.25	13
IMIB	0.164	0.028	0.013	0.012	0.068	0.048	0.285	0.14	15
IMCL	0.079	0.025	0.012	0.051	0.075	0.089	0.253	0.26	12
IITC	0.077	0.246	0.008	0.006	0.078	0.263	0.117	0.69	1
IIEW	0.031	0.031	0.002	0.006	0.072	0.143	0.237	0.38	6
IKLV	0.028	0.011	0.003	0.006	0.072	0.144	0.254	0.36	9
IBSD	0.036	0.023	0.032	0.006	0.079	0.140	0.235	0.37	7
IIDP	0.001	0.015	0.012	0.006	0.071	0.170	0.246	0.41	4
IMAP	0.151	0.025	0.012	0.004	0.080	0.055	0.281	0.16	14
IRMC	0.022	0.018	0.097	0.006	0.083	0.178	0.229	0.44	2
IBPM	0.011	0.026	0.016	0.006	0.082	0.162	0.235	0.41	3
TASC	0.036	0.026	0.008	0.004	0.080	0.138	0.241	0.36	8
AIPM	0.058	0.021	0.017	0.006	0.067	0.117	0.245	0.32	11
AIRP	0.039	0.020	0.014	0.006	0.072	0.135	0.244	0.36	10

The table (13) of maximum and minimum values for each dimension of the evaluation illustrates the broad performance of companies. The "Best" column represents the highest value a company can achieve in each dimension, while the "Worst" column represents the lowest recorded performance. Observing these values, we find that the financial and internal operations dimensions exhibit significant variation among companies, indicating clear differences in their financial performance and their ability to manage internal operations. In contrast, the learning, growth, and budgeting dimensions show less variation, reflecting that most companies are relatively similar in these aspects of performance. Using the midpoint between the maximum and minimum values for each dimension provides a relative benchmark for identifying companies that can be considered relatively close to the ideal solution. This makes the revised hypothesis more flexible and realistic, rather than relying on a fixed, hypothetical threshold. .

Table 13. Best and Worst values

Calculate Best and Worst values				
Worst	0.164	0.002	0.001	0.051
Best	0.001	0.246	0.097	0.004

The Ci score table reflects the ranking of companies based on their relative proximity to the ideal solution according to the TOPSIS model. Companies at the top of the ranking, such as Iraqi Carpets and Furnishings, have relatively low scores, indicating their proximity to the ideal solution. Conversely, companies at the bottom of the list, such as National Metal Industries and Bicycles, have higher scores, suggesting their proximity to the ideal solution. The table also reveals a significant number of companies within the average performance range, with scores between 0.24 and 0.25, indicating relative homogeneity in performance across several dimensions. This homogeneity reflects that most companies achieve a good average performance level, despite clear differences in some dimensions.(see table 14)

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Table 14. rank the companies

Rank	companies	Score
1	AMAP	0.12
2	IMOS	0.23
3	IMIB	0.23
4	IMCL	0.25
5	IITC	0.25
6	IIEW	0.24
7	IKLV	0.24
8	IBSD	0.24
9	IIDP	0.25
10	IMAP	0.24
11	IRMC	0.25
12	IBPM	0.25
13	TASC	0.27
14	AIPM	0.28
15	AIRP	0.28

5.2.3. Analysis of the H1 Hypothesis Test Using the Midpoint Criterion

Using the midpoint criterion for each dimension, companies that can be considered relatively close to the ideal solution can be identified. The average between the best and worst values for each dimension was calculated, and this average serves as a benchmark for evaluating relative performance. When comparing each company's Ci score with the average, it becomes clear that almost all companies exceed this benchmark in most dimensions, meaning they fall within the relatively acceptable performance range. For example, companies such as Iraqi Carpets and Furnishings, Ready-Made Garments Production, and Baghdad Packaging Materials Manufacturing achieved Ci scores below the average, confirming their good proximity to the ideal solution. While the companies at the bottom of the ranking, despite having higher scores, are still close to the average in several dimensions, reflecting that the overall performance of the companies is relatively good.

This analysis supports the modified H1 hypothesis, as it demonstrates that most companies have a relative proximity to the ideal solution that exceeds the average of the values between the upper and lower limits of each dimension, and therefore can be considered within the relatively good performance range.

5.3. Testing the Study Hypotheses and Discussing the Statistical Results

After verifying the psychometric efficiency of the study instruments, the crucial stage of testing causal hypotheses using Structural Equation Modeling (SEM) via AMOS software was undertaken. This analysis aims to explore the relationships between the Balanced Scorecard, the effectiveness of accounting information systems, and sustainable performance. The following is a presentation and analysis of the results:

5.3.1. The Impact of the Balanced Scorecard on Sustainable Performance (H2)

The path analysis revealed a significant and positive impact of the Balanced Scorecard as an integrated framework on sustainable performance, with an impact strength of 0.447. This indicates that promoting the use of this strategic tool directly contributes to improving the economic, environmental, and social dimensions of sustainability. Looking at the sub-dimensions, we find a variation in the level of impact. The financial dimension emerged as the most influential, followed by internal processes and then customers. The growth and learning dimension, however, failed to achieve statistical significance, suggesting a gap in translating intangible and training investments into concrete sustainability outcomes in the near term. (see table 15)

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Table (15): Results of the BSC Impact Test on Sustainable Performance

Independent Variable (Card Dimensions)	Regression Coefficient (β)	Critical Value (CR)	Significance Level (P)	Statistical Decision
BSC (Overall)	0.447	4.504	0.000	Accept (H2)
Financial Dimension	0.226	5.015	0.000	Accept (H2a)
Customer Dimension	0.053	3.239	0.000	Accept (H2b)
Internal Processes	0.145	3.317	0.000	Accept (H2c)
Growth and Learning	0.004	0.094	0.925	Reject (H2d)

5.3.1.1. Examining Relationships with Control Variables

To ensure the accuracy of the results, the variables of debt, company size, and company age were introduced into the model. The results showed the continued strong influence of the Balanced Scorecard, with debt and company age emerging as significant organizational factors supporting sustainable performance. Company size, however, did not make a significant difference in predicting the level of sustainability, confirming that the adopted strategy is more important than the physical size of the organization. (see table 16)

Table (16): Model Results with Control Variables

Variable	Regression Coefficient (β)	Critical Value (CR)	Significance Level (P)	Statistical Decision
BSC	0.560	5.914	0.000	Statistically Significant
Debt Structure	0.158	3.317	0.000	Statistically Significant
Company Size	0.026	0.521	0.602	Not Significant
Company Age	0.146	3.824	0.000	Statistically Significant

5.3.1.2. The Mediating Role of Accounting Information Systems Effectiveness (H3)

This study explored the mediation hypothesis to examine whether accounting information systems act as a conduit for transmitting the impact of the scorecard on sustainable performance. Using Bootstrap analysis, the results showed that these systems play an effective "partial mediating" role in the financial dimension and the growth and learning dimension. This means that the effectiveness of accounting systems enhances an organization's ability to translate financial stability and knowledge growth into strategic decisions that support sustainability. In contrast, no mediating effect of these systems was found in the relationship between (customers/internal processes) and sustainable performance, indicating that the impact of these dimensions is reflected either directly or through non-accounting channels. (see table 17)

Table (17): Summary of the Mediating Effect Results (AIS)

Mediating Path	(B)	Bootstrap	(P-value)	Mediation Result
Financial->AIS> Sustainability	0.018	4.019	0.000	Accept (H3a)
Customers->AIS-> Sustainability	0.003	1.734	0.342	Reject (H3b)
Processes->AIS-> Sustainability	0.006	1.030	0.342	Reject (H3c)
L.Growth->AIS-> Sustainability	0.073	2.976	0.040	Accept (H3d)

analysis:
The results of this chapter confirm that the Balanced Scorecard is not merely a measurement tool, but a strategic driver of sustainable performance. Its effectiveness increases when combined with efficient accounting information systems capable of providing accurate data that supports financial and innovative decisions. The results also indicate the need to reconsider "growth and learning" mechanisms to directly target them towards sustainability goals, ensuring their impact is reflected in future statistical models.

5.3.2. Analyzing the Impact of Budgeting and the Mediating Role of Information Systems

This section examines the strategic role of budgeting as a planning and control tool and its impact on sustainable performance, while also testing the extent to which the effectiveness of accounting information systems contributes to strengthening this relationship.

5.3.2.1. The Impact of Budgeting on Sustainable Performance (H4)

The path analysis results showed a statistically significant positive impact of budgeting as an integrated framework on sustainable performance (beta = 0.256). A detailed dimension analysis revealed that "managerial participation in budget preparation" and "long-term objectives" are the most influential factors in achieving sustainability, reflecting the importance of the behavioral and strategic dimensions in budget success. In contrast, "information system and budget complexity" did not yet show any significant impact, which may be attributed to the fact that complexity itself can be an obstacle rather than a driver of performance unless accompanied by simplification and technological integration.(see table 18)

Table (18): Results of the Impact of Budgeting on Sustainable Performance Test

Independent Variable	(B)	(CR)	(P-value)	Statistical Decision
Estimated Budget (Overall Effect)	0.256	2.868	0.004	Accepted (H4)
Managers' Participation	0.262	3.176	0.001	Accepted (H4a)
Long-term Objectives	0.245	2.575	0.010	Accepted (H4b)
Resource Allocation	0.151	2.705	0.012	Accepted (H4c)
Continuous Improvement	0.149	2.018	0.044	Accepted (H4d)
Budget Preparation Complexity	0.043	0.633	0.527	Rejected (H4e)

5.3.2.2. Stability of the Relationship with Controlling Variables

When controlling variables (debt, company size, and company age) were included, the budget continued to show a substantial effect, confirming the model's robustness. Notably, "company age" and "debt structure" showed significant relationships, indicating that more mature companies and those with clear financial structures are better able to invest budgets in improving sustainability. (see table 19)

Table (19): Model Results with Controlling Variables (Budget)

Variable	(B)	(CR)	(P-value)	Decision
Estimated Budget	0.292	3.424	0.000	Statistically Significant
Debt Structure	0.180	3.610	0.000	Statistically Significant
Firm Size	0.054	1.002	0.316	Not Statistically Significant
Firm Age	0.209	3.813	0.000	Statistically Significant

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ISSN: 1053-7899
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5.3.2.3. The Mediating Role of Accounting Information Systems (H5) Test

The mediation test using Bootstrap revealed a vital and multifaceted role for accounting information systems. The systems acted as the "major mediator" in the cases of long-term objectives and resource allocation, meaning that the impact of these two dimensions on sustainability is only truly realized through an effective accounting information channel. Mediation was "partial" in the case of managerial involvement and completely absent in the case of continuous improvement, where the latter's impact is direct and independent. (see table 20)

Table (20): Summary of the Mediating Impact of Information Systems between Budgeting and Sustainability

Sub-Hypotheses Mediation Path	Indirect Effect (B)	Bootstrap Value	(P-value)	Mediation Result
Managers' Participation →AIS → Sustainable Performance	0.173	19.860	0.000	Partial Mediation (H5a)
Long-term Objectives → AIS → Sustainable Performance	0.096	6.234	0.043	Full Mediation (H5b)
Resource Allocation → AIS → Sustainable Performance	0.021	46.800	0.000	Full Mediation (H5c)
Continuous Improvement → AIS → Sustainable Performance	0.004	1.800	0.214	No Mediation (H5d)

<u>Analysis</u>:

The results demonstrate that budgeting is not merely a collection of cold, hard numbers, but rather a behavioral and strategic framework that supports sustainability. The "holistic integration" of information systems into resource allocation and strategic objectives sends a powerful message to decision-makers that investing in the quality of accounting systems is a prerequisite for translating financial plans into tangible sustainability outcomes.

5.3.3. Analyzing the Impact of Integration and the Mediating Role of Information Systems (H6)

This section of the study examines the core hypothesis reflecting the research's strategic vision: the impact of integration between the Balanced Scorecard and the Budget on achieving sustainable performance. It also tests the extent to which information systems contribute to enhancing this integration.

5.3.3.1. The Direct Impact of Integration on Sustainable Performance (H6-1)

The path analysis results showed a strong and statistically significant positive relationship between the degree of integration and sustainable performance. The regression coefficient (beta = 0.434) indicates that integration contributes 43.4% to improving sustainability practices (economic, social, and environmental). (see table 21)

Table (21): Results of Assessing the Relationship Between Integration and Sustainable Performance

Relationship between Variables	(B)	(CR)	(P-value)	Statistical Decision
Integration of Tools (BSC + Budgeting) →Sustainable Performance	0.434	5.318	0.000	Statistically Significant (H6-1 Accepted)

5.3.3.2. Stability of the Integration Relationship with Controlling Variables

When controlling variables were introduced to ensure the accuracy of the results, the integration effect coefficient increased to (beta = 0.523), confirming that integration is the primary driver of sustainable performance even when controlling for other regulatory factors. (see table 22)

Table (22): Model Results with Controlling Variables (Integration Model)

Variable	(B)	(CR)	(P-value)	Decision
Integration (BSC + Budgeting)	0.523	6.879	0.000	Statistically Sig.
Firm Size	0.209	4.196	0.000	Statistically Sig.
Debt Ratio	0.187	4.029	0.000	Statistically Sig.
Firm Age	0.058	1.199	0.230	Not Statist.Sig.

5.3.3.3. The Mediating Role of Accounting Information Systems (H6-2)

The mediating role of accounting information systems in the relationship between integration and sustainable performance was examined. The results showed that information systems play a pivotal role as a "partial mediator," where integration improves system effectiveness, which in turn positively impacts the accuracy of sustainability reports. (see table 23)

Table (23): Results of the Mediating Effect (Integration, Information Systems, Sustainable Performance)

Path	(B)	Bootstrap	(P-value)	Result
Direct Effect (Integration of Tools → Sustainable Performance)	0.497	5.297	0.000	Statistically Significant
Direct Effect (Integration of Tools →AIS→ Sustainable Performance)	0.009	25.230	0.000	Statistically Significant
Type of Mediation	Partial Mediation	–	–	H6-2 Accepted

Analysis:

The results confirm that the integration of the Balanced Scorecard and budgeting represents a significant leap forward in sustainable performance. The partial mediation of information systems means that this integration has a direct impact through strategic alignment and an indirect impact by providing a robust accounting information infrastructure that enables management to accurately track sustainability indicators.

6. Key Findings

The study concluded that TOPSIS assessment results confirm that leading companies are the most successful in achieving strategic integration between their budgets and the Balanced Scorecard. These leading companies are the most diligent in balancing their financial and non-financial performance, according to TOPSIS results. They have approached the optimal solution by effectively allocating financial resources to support customer and operational aspects. Conversely, the low index for other companies (0.14) reflects a weakness in the "linkage effect," indicating that budget resources are spent in directions unrelated to qualitative growth. This disparity underscores that sustainable performance hinges on bridging the gap between planned operational spending and strategic outputs. This explains why most companies are concentrated in the average performance zone, resulting from a balance of power between financial and operational requirements. The study found that the integration of the Balanced Scorecard (BSC) with the budget is the strongest driver of sustainable performance, with an impact factor of 0.523. This demonstrates that the link between strategic vision and financial execution is more important than relying on each tool in isolation. The study also revealed the role of both macro and micro mediation in the effectiveness of accounting information systems. It was found that budgeting is not merely a recording tool, but a vital channel that transforms estimated budget objectives into tangible, sustainable performance results. The study also found that the dimensions of "management involvement in budgeting" and "clarity of long-term goals" have the greatest impact on sustainability, while system complexity showed no positive effect, indicating that the human and strategic elements outweigh technical complexity. Regarding the shortcomings of continuous improvement, the results showed that "continuous improvement" alone may not be sufficient to achieve significant leaps in sustainable performance unless supported by a robust information system that links improvement results to environmental and social indicators.

The results of the control variables test, which examined the stability of the initial model results, showed that "company size" and "debt ratio" positively affect an organization's ability to achieve sustainability. This means that large companies with financial solvency and abundant resources are better positioned to adopt integrated performance models.

Recommendations

The study establishes a number of points across several key areas, most notably the following:

1. Recommendations related to institutional and technical development:

• Activating functional integration: The necessity of moving from working in isolation to a systematic and automated link between the strategic planning unit (responsible for the balanced scorecard) and the financial management unit (responsible for the budget).

• Developing accounting information systems: Investing in transforming traditional accounting information systems into "sustainability information" systems capable of tracking carbon footprint, social responsibility, and economic efficiency simultaneously.

2. Recommendations related to administrative and behavioral aspects:

• Strengthening participatory budgeting: Encouraging the participation of managers at all levels in the budgeting process to ensure their self-commitment to the objectives and reduce the organization's resistance to change towards sustainability.

• Adopting a long-term perspective: Restructuring estimated budgets to become "strategic budgets" that cover time cycles aligned with sustainability goals (3-5 years) instead of traditional annual budgets only. 3. Corporate Policy Recommendations:

• Linking Rewards to Sustainable Performance: The study recommends linking corporate incentive systems to integration indicators (balancing financial profit with social and environmental impact).

• Information-Efficient Resource Management: Resource allocation should be based on comprehensive cost-benefit reports provided by information systems to ensure that investments are directed toward projects that best support sustainability.

Conclusion

This research concluded that both the Balanced Scorecard and budgeting have a positive and independent impact on enhancing sustainable performance in the studied companies. Each tool individually affects strategic planning, resource control, and the achievement of long-term goals. The results also confirmed that integrating the Balanced Scorecard with budgeting has a stronger and more comprehensive impact on sustainable performance compared to studying each tool separately. This highlights the importance of adopting an integrated methodology that links strategic planning with short-term budgeting processes..

The results also demonstrated the role of accounting information systems as an effective mediator in the relationship between budgeting and sustainable performance. These systems transform financial and operational data into valuable information that supports decision-making. It was observed that the nature of this mediation varies between the macro and micro levels depending on the dimensions of the budget. Furthermore, the study showed that control variables, such as company size and debt ratio, significantly influence the relationship between integration and sustainable performance, while company age had a minimal impact. This indicates that the influence of organizational factors varies according to the nature of the organization and its operating environment.

Accordingly, the research emphasizes the importance of adopting integrated strategies between the balanced scorecard and the estimated budget, supported by effective accounting information systems, to achieve sustainable performance improvement, and provides researchers and practitioners with a practical framework for understanding the relationship between strategic planning and control tools and their impact on performance sustainability in companies...

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