



The Impact of Employing Big Data Technologies on Cost Measurement Efficiency and Enhancing Competitive Advantage: An Exploratory Study

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Abstract. This study aimed to diagnose the reality and requirements of applying Big Data technologies in the sample companies, measure the efficiency level of cost measurement systems, their ability to transition toward real-time predictive costing, and determine the level of enhancing competitive advantage across its strategic dimensions (cost leadership, differentiation, flexibility, and speed). To achieve the study's objectives, a descriptive-analytical approach was relied upon to diagnose the trends of the sample members, consisting of (100) individuals distributed across (3) companies listed on the Iraq Stock Exchange. The study obtained statistical results that proved the existence of a statistically significant positive impact of Big Data technologies on the increase of the efficiency of cost measurement with a direct path of (0.4850) and the total interactive indirect impact on the increase of competitive advantage of (0.5382) through the efficiency of cost measurement as a mediating variable. In addition, the results of the One-Way Analysis of Variance (ANOVA) showed that there were no statistically significant differences at the level of significance (0.178) between the responses of the sample members due to the economic sector variable, which indicated a common professional maturity and awareness of the importance of cost digitalization. One of the primary suggestions of the study is the need to move gradually from traditional systems to new systems in an effort to help improve indirect cost allocation, increase measurement efficiency, and improve competitive advantage.

Keywords: Big Data Technologies, Cost Measurement, Competitive Advantage.

1. Introduction

The present century has witnessed a drastic change in the intellectual and technological spheres due to the digital revolution and the flow of huge volumes of data

from different sources and in different formats. Such technological development has led economic entities to reassess their administrative and costing systems to cope with the demands of a highly competitive environment. Management accounting and cost measurement systems are among the disciplines most affected by this digital transformation, because traditional methodologies based on historical data can no longer give management an accurate perspective of indirect costs and their real drivers.

In this sense, Big Data Technologies represent a strategic instrument that enables economic agents to collect and analyze in real time, streaming financial and non-financial data from different operations. The transition to Big Data processing increases the accuracy of cost allocation, decreases operational waste, and allows for the use of new approaches such as Time-Driven Activity-Based Costing (TDABC) and budgeting. Accounting excellence in regulating the cost structure is the strategic basis for developing competitive advantage based on cost leadership, differentiation and flexibility in responding to market demands in listed firm.

Section One: Methodology and Previous Studies

First: Methodology

1-Research Problem

The research challenge is the structural defect that traditional cost assessment systems suffer from in absorbing unstructured data that flows continuously from the internal and external environment of companies listed on the Iraq Stock Exchange. Traditional ways of assigning overhead costs result in distortions of cost and a side effect of cross-subsidizing products, limiting management's capacity

to make correct pricing decisions and weakening its competitive position in the marketplace.

The increasing awareness of the value of advanced technology is accompanied by a knowledge and application gap on how to directly apply Big Data technologies in constructing predictive cost models that contribute to boosting competitive advantage. Hence, the main question of the research arises: "What is the impact of applying Big Data technologies on the efficiency of cost measurement and the enhancement of competitive advantage?"

From this main question, the following sub-questions branch out:

- a. What is the level of awareness and application of Big Data technologies among accountants in the sample companies?
- b. Do Big Data technologies directly affect the efficiency of cost measurement?
- c. Do Big Data technologies and cost measurement efficiency contribute to enhancing competitive advantage in its strategic dimensions?
- d. Does cost measurement efficiency play a mediating role in enhancing the impact of Big Data on competitive advantage?

2-Research Importance

- a. Enriching Arabic and Iraqi accounting and administrative literature by shedding light on the knowledge integration between data science and strategic management accounting, and providing a theoretical and structural framework that illustrates the relationship between Big Data technologies, cost measurement efficiency, and competitive advantage.
- b. Providing empirical results and indicators based on the opinions of (100) experts in (3) companies listed on the Iraq Stock Exchange, contributing to guiding top management, accountants, and auditors on how to leverage Big Data analytics to develop waste-control tools, improve the quality of financial and managerial reports, and build sustainable competitive advantages that enhance market share and corporate profitability.

3-Research Objectives

This research seeks to achieve the following strategic and sub-objectives consistent with the study title:

- a. Diagnosing the reality and requirements of applying Big Data technologies in the sample companies listed on the Iraq Stock Exchange.
- b. Measuring the efficiency level of cost measurement systems and their capacity to shift toward real-time predictive cost determination.

c. Determining the level of enhancing competitive advantage across its strategic dimensions (cost leadership, differentiation, flexibility, and speed).

d. Testing the direct and indirect impact of Big Data technologies on enhancing competitive advantage via cost measurement efficiency as a mediating variable using path analysis.

4-Research Hypotheses

The statistical hypotheses of the study were established to directly align with the objectives and title of the study:

First Sub-Hypothesis (H1): There is a statistically significant effect of using Big Data technologies at a significance level of ($\alpha \leq 0.05$) in raising the efficiency of cost measurement.

Second Sub-Hypothesis (H2): There is a statistically significant effect of applying Big Data technologies at a significance level of ($\alpha \leq 0.05$) in enhancing competitive advantage.

Third Sub-Hypothesis (H3): There is a statistically significant effect of cost measurement efficiency at a significance level of ($\alpha \leq 0.05$) in enhancing competitive advantage.

Fourth Main Hypothesis (H4): There is a statistically significant effect of the interactive integration and indirect path of Big Data technologies through cost measurement efficiency as a mediating variable in enhancing competitive advantage at a significance level of ($\alpha \leq 0.05$).

5-Data and Information Collection Tools:

- a. Theoretical Framework Tools: To enrich the theoretical aspect, the researcher relied on scientific journals, periodicals, and research studies related to the research variables, in addition to using the Internet and its electronic research resources to support the theoretical framework with relevant information.
- b. Fieldwork Tools: In preparing the fieldwork component of the research, the researcher relied on a questionnaire distributed to (120) experts and practitioners (accountants, auditors, financial managers).

6-Research Spatial and Temporal Boundaries:

- a. Temporal Boundaries: Represented by the financial data for the year (2025).
- b. Spatial Boundaries: Targeted a sample of 3 companies listed on the Iraq Stock Exchange (National

Bank of Iraq, Mansour Bank for Investment, Baghdad Soft Drinks Co.).

7-Research Methodology:

The research adopted the descriptive-analytical methodology due to its suitability to the nature of the

current study. The descriptive aspect was used to clarify concepts related to Big Data technologies, cost measurement, and competitive advantage. The analytical methodology was used to test correlation and impact relationships between research variables and statistically analyze the questionnaire results.

Second: Previous Studies

Researcher, Year	Study Title	Study Type	Objective of the Study	Key Conclusions
First: Iraqi Studies				
(Al-Ghaban et al., 2024)	Proposed Operational Vision for Adopting Strategic Cost Management Tools to Improve the Efficiency and Effectiveness of the Cost System Applied in Iraqi Units.	Exploratory study in Iraqi economic units / Published research.	Evaluating the efficiency of the applied cost system in Iraqi units and the role of modern strategic cost management tools in upgrading accounting measurement mechanisms and rationalizing performance.	The necessity of adopting modern strategic cost management methods to improve the effectiveness of existing cost systems and reduce financial and operational waste in Iraqi economic units.
(Al-Mueini, 2011)	Cost Management Techniques Required for Arab Business Organizations and the Sustainability of Competitive Advantage: A Proposed Integrative Framework for Continuous Improvement Techniques.	Survey analytical study of Iraqi and Arab business organizations / Published research.	Exploring the impact of advanced cost management techniques in bridging the cost information gap and achieving sustainable competitive advantage in economic units.	The inability of traditional cost systems to provide relevant information for cost reduction, and that adopting advanced techniques represents the primary path to achieving and sustaining competitive advantage.
Second: Arab Studies				
(Hafsa et al., 2025)	The Role of Big Data Analytics in Enhancing Competitive Performance - A Field Study at the Algerian Telecommunications Corporation.	Field study using Structural Equation Modeling (Smart-PLS) on a sample of 89 individuals / Published research.	Identifying Big Data and the role of its analysis in enhancing the competitive performance of enterprises in the telecommunications sector.	The existence of a significant positive impact of Big Data applications in enhancing competitive performance by (64.8%), with the largest effect concentrated on the productivity dimension by (55%).
Third: Foreign Studies				
(Salijeni et al., 2019)	Big Data Analytics and the Transformation of Accounting and Auditing Practices.	Comprehensive analytical survey study of international practices and experiences / Published research.	Analyzing the impact of Big Data analytics and structural changes in the accounting measurement, control, and financial auditing process.	Exploiting Big Data analytics enhances the ability of economic units to make future predictions, raising business efficiency and operational response flexibility.
(Sun et al., 2021)	Literature Study of The Influence of Big Data and Data Analytics on Cost Controls.	Survey study of global literature on cost control / Published research.	Examining how real-time Big Data analytics is used in controlling operational costs and rationalizing	Real-time Big Data analysis provides a high competitive advantage and helps rationalize costing

			strategic decision-making.	decisions and control waste in a global competitive environment.
(Coyne et al., 2018)	Big Data Information Governance by Accountants.	Analytical study of accounting governance systems / Published research.	Highlighting the role of management accountants in governing Big Data technology and exploiting it to provide strategic cost reports.	Governance of Big Data by accountants enables the extraction of high-value costing data, thereby raising the competitive and operational efficiency of organizations.

(Prepared by the researcher based on the sources above)

1-Similarities:

- The current study agrees with all previous studies in emphasizing the vital role of digital development and technological infrastructure in enhancing the efficiency of financial and accounting management and achieving competitive excellence.
- This study is similar to most reviewed studies in relying on the descriptive-analytical approach, using the questionnaire as a primary tool for collecting field data, and relying on advanced statistical methods to test hypotheses.
- The study aligns with studies by (Al-Mueini, 2011; Abdul-Qader, 2021; Sun et al., 2021) in that controlling indirect costs and tracking cost drivers represents the central pillar for cost leadership and price differentiation.

2-Differences and Points of Distinction of the Current Study:

- Most previous Iraqi and Arab studies focused either on cost management methods alone or the impact of technology on competitive performance in general without integrating a direct mediator. The current study is distinguished by presenting an integrated interactive model linking Big Data technologies (independent variable) to cost measurement efficiency (mediating variable) leading to the enhancement of competitive advantage across its dimensions (dependent variable).
- The present study is different from previous studies because it uses Path Analysis to measure direct and indirect effects and to determine the added value of cost measurement efficiency as a mediating variable that transfers technical competence into actual competitive advantages.
- The study provided a field study of the views of a sample of (100) individuals in (3) companies listed on the Iraq Stock Exchange, which is unique in providing a comparison between the industrial sector and the service/banking sector through the (ANOVA) test to study the homogeneity of professional and supervisory trends toward the digitalization of costs.

Section Two: Theoretical Framework

First: Evolution and Concept of Big Data

The data odyssey started with a 1944 forecast by Fremont Rider that libraries would double every 16 years. By 1975 this had developed into tracking the flow of information in Japan, and the accompanying growth in supply relative to consumption. In the 1990s, Denning (1996) noted that data transmission was difficult, but digital storage was much more expensive than paper. In 1999, the world produced 1.5 zettabytes of data. In 2001, Meta Group identified the dimensions of Big Data (Volume, Velocity, and Variety), leading to cloud computing (2007) and the Internet of Things (2013). Global storage capacity hit 49.5 zettabytes in 2019 with investment increase of about \$41.5 billion and this trend will continue (Al-Khafaji, 2024: 16-19).

The term “Big Data” mainly refers to the large amount of data generated, stored and processed by means of current technology to exploit flows of information. This data helps firms to discover their strengths and possibilities and enhance their decision-making processes (Al-Shatnawi, 2022: 468). Big Data Technologies comprising Analytics is about collecting, processing and analyzing huge and complex datasets defined by volume, velocity and diversity. These datasets can originate from diverse sources, including social media, sensors, transaction systems, and others.

The goal is to uncover insights, patterns, and trends that are difficult to detect using traditional data analysis methods (Emma, 2024: 2).

The importance of Big Data technologies lies in the following (Al-Khafaji, 2024: 27-28)(Loebbecke & Picot, 2015: 154-156) (Abdul-Hussein & Oujah, 2024: 33-34):

- 1.Raising the quality and reliability of financial reports: Real-time processing allows integrated information flows that eliminate time gaps in preparing financial reports.
- 2.Reducing earnings management and accounting deception: These technologies enhance transparency and control, reducing opportunities for account manipulation or deceptive accounting tactics.
- 3.Transitioning toward future and predictive information systems: Enabling economic entities to move from historical data retrieval to future orientation and predictive analysis, with the ability to integrate external non-financial data with internal data of the economic entity.
- 4.Improving the quality and reliability of financial reporting and reducing misleading accounting practices and improving earnings management through real-time processing that eliminates time lags in report preparation.
- 5.The importance of these technologies is clearly manifested in the field of cost measurement and management. They play a crucial role in lowering operational costs and improving resource utilization efficiency by providing a comprehensive vision and real-time tracking of inventory movement and the supply chain, in addition to early prediction of equipment failures, which reduces material and time waste.

Second: Types and Sources of Big Data

Big Data is divided into three types as follows (Al-Khafaji, 2024: 19-20)(Abdul-Hussein & Oujah, 2024: 35):

- 1.Structured Data: Refers to data organized and arranged in a specific, systematic manner. It features a defined structure that it follows, whether at the level of the data itself or at the level of the databases that store it.
- 2.Unstructured Data: Data that is difficult to classify easily, forming a large portion of Big Data sets. This includes content written on social media and videos. Human-generated data is a rich source of information, images, blogs, and emails.
- 3.Semi-structured Data: A hybrid of structured and unstructured data, referring to data that resembles structured data but is not organized in tables or databases. It typically appears as text on web pages or within logs.

The following are the sources of Big Data (Al-Khafaji, 2024: 20):

- 1-Internal Data Sources: Data created from the databases of the economic body. It contains operational data, consumer data and data from Enterprise Resource Planning (ERP) systems and internal control systems. The data is displayed in the form of graphics, charts, figures etc. which are easily accessible.
- 2-External Data Sources: Data received from sources outside the economic entity's ownership and control. These sources range from the Internet and social media to stock trading records and competitors' records.

Third: Cost Measurement

Cost identification and evaluation are the two building blocks underlying modern management. Modern-day perception of cost has transcending actual monetary spending to constitute an advanced strategic tool for assessing operational performance, via available factors and relating costs with customer and market values (Al-Rubaiei, 2022: 15-18). Cost is the giving up of economic benefits (usually measured by cash inflows or liabilities) to obtain possible subsequent benefits [Horngren et al., 2018, p. 29].

Measuring activity costs helps determine the cost of each cost element (materials, labor, and services) and the expected needs for each in the production process. It also helps determine the costs of work-in-process and finished goods, and consequently the cost of producing a single unit. Based on this, management can set an appropriate selling price. Unit cost determination contributes to setting selling prices under normal conditions and helps determine operational results (profit or loss) at the end of the period. It also aids in performance measurement by comparing standard costs with actual costs, identifying variances, and holding responsible personnel accountable (Aina, 2025: 31). Cost measurement is defined by the Institute of Management Accountants (IMA) as the quantitative process of determining the monetary value of resources consumed in accomplishing an activity, providing a service, or manufacturing a product, based on objective and verifiable standards (IMA, 2014: 12-18).

The objectives of cost measurement are as follows (Blocher et al., 2019: 118-125) (Drury, 2018: 95):

- 1-Evaluating Responsibility Center Efficiency: Allows the administrative system to measure the performance of departments, production, and service centers by determining their efficiency in consuming available resources.
- 2-Determining Appropriate Pricing Policies: Provides an accurate and reliable database upon which pricing decisions for goods and services are built to ensure cost coverage and achieve a targeted and competitive profit margin.
- 3-Rationalizing Administrative Decisions: Supporting top management in making critical decisions such as accepting or rejecting special orders, make-or-buy decisions, or continuing versus discontinuing a specific production line.
- 4-Financial Forecasting and Planning Needs: Historical and standard cost outputs serve as primary inputs for preparing budgets, estimating cash flows, and determining working capital and future resource requirements.
- 5-Enhancing Competitive Advantage: Contemporary measurement systems (such as activity-based costing and time-driven costing) aim to focus on value-added activities and eliminate non-value-added activities, contributing to overall cost reduction and enhancing the organization's competitive position.

Fourth: Competitive Advantage

The concept of competitive advantage began to emerge in the early 1980s. Porter is considered the first to contribute to this field through his 1985 work titled *Competitive Strategy* (Gashi, 2013: 63). The term competitive advantage refers to the ability of an economic entity to achieve a better position than its competitors in the same sector. Through competitive analysis, the unit seeks to define the nature of its competitive advantage, which reflects its ability to maintain superiority over a longer period. Competitive advantage arises from characteristics that distinguish the entity's products or brand, helping it meet consumer needs more efficiently and effectively than competitors, achieving higher profit margins, offering more competitive prices, and increasing market share (Saleh & Bani, 2013: 86).

For Awamleh & Ertugan (2021: 24), competitive advantage is an organization's ability to be unique in its capacity to outperform its competitors in the same industry, creating value in the eyes of customers and in the long run, maintaining its position in the market. This idea is associated by Obeidat et al. (2021: 115) to value creation, which they define as the provision of benefits that are equivalent to or better than those of competitors through either reduced total costs or distinctive qualities that explain price disparities. Farida & Setiawan (2022: 3) state from a dynamic point of view that competitive advantage depends on the strategic capacities to rearrange internal resources and adapt to environmental and technological changes.

The aspects of competitive advantage are as follows (Al-Fadhl & Ghadeer, 2013: 242-243)(Farida & Setiawan, 2022: 5):

- 1-Cost Dimension: A basic pillar in industrial sectors with standardized goods by using modern systems/technologies that optimize manufacturing costs without compromising standards.
- 2-Quality Dimension: It includes rigorous conformity to standards and products without fault. It is closely tied to cost as well as lowering defective items impacts positively on total expenses.
- 3-Flexibility Dimension: It is the ability of production systems to adjust quickly to changes in demand, therefore minimizing the cost of unused energy and improving the utilization of resources.
- 4-Delivery Dimension: It is an indicator of the efficiency of delivery times, a key factor in establishing reliability and continuity of operations.
- 5-Innovation Dimension: Use of the latest technology and analytics on data in the operation workflow, to explore innovative ways to decrease costs and boost operational efficiency.

Fifth: Impact of Big Data Technologies on Cost Measurement Efficiency and Enhancing Competitive Advantage

The management accountant has a very important duty that no economic unit can disregard. The modern management accountant is characterized as one whose job is not only to measure real expenses from a traditional point of view but also to the analytical, advising and strategic planning aspects. They participate actively in phases of decision-making with the use of current technologies including Big Data. Their major function is to guide the use of technology in creating value and meeting consumer needs in competitive markets. Accounting systems process both actual and planned results from the perspective of predetermined costs (estimated or standard). This system serves as an essential incubator for Big Data analytics, unlike financial accounting information. This is increasingly vital for large companies like Amazon, Google, Apple, Samsung, and banking, transport, and telecom sectors handling Big Data. These firms need information management systems, cybersecurity, and cloud servers to store primary and secondary data. This requires management accounting systems to redesign their analysis and implementation to keep pace with Big Data requirements (Al-Naqeeb et al., 2022: 1537).

Big Data technologies have become crucial tools in developing accounting information systems and cost management systems due to their capabilities in collecting, processing, and analyzing massive volumes of data. This helps entities obtain comprehensive information on operational activities to support cost measurement, resource allocation, and managerial decision-making (Bhimani, 2020: 11-12). Big Data improves cost measurement efficiency by linking financial data with operational and non-financial data, helping management identify cost drivers accurately, detect resource-consuming activities, and identify waste and cost variances. Advanced analytics allow faster and more detailed data processing, enhancing management accounting systems' ability to provide relevant information for control, planning, and decision-making (Cockcroft & Russell, 2018: 323-324).

Possessing accurate and timely information on costs, customers, and markets enables management to improve product quality, respond quickly to environmental changes, and reduce unnecessary costs. Utilizing Big Data analytics enhances institutional performance by developing dynamic capabilities and boosting environmental responsiveness (Wamba et al., 2017: 356–365).

Furthermore, (Jasim,2025: 3701) points to a statistically significant impact of integrating Big Data technologies with strategic cost management in enhancing competitive advantage dimensions (such as cost reduction, service quality, and price flexibility). (Barreto et al,2025:34) demonstrate that advanced digital tools provide management with real-time capabilities to monitor financial waste and formulate cost leadership and differentiation strategies with high efficiency.

Section Three: Empirical Framework

First: Description of the Study Population

Another important factor which directly influences the success of the study is the selection of study population. The population is the economic enterprises listed on the Iraq Stock Exchange. The study and hypotheses were tested on a random sample of auditors and accountants in the entities covered by the survey, which amounted to (120) individuals. Number of respondents reached (100) persons.

Second: Respondent Sample Demographic Profile

(100) financial and auditing professionals working in (3) companies listed on the Iraq Stock Exchange were surveyed. The following tables present the sample's demographic and professional characteristics:

Table (2): Distribution of Respondents According to Age

Age Group	Frequency	Percentage (%)
25 to less than 30 years	15	15.0%
30 to less than 40 years	42	42.0%
40 to less than 50 years	28	28.0%
50 years and above	15	15.0%
Total	100	100%

The material was compiled by the researcher from the field investigation.

The data indicated that the biggest proportion of the sample is concentrated in the age group (30 to less than 40 years old) with a rate of (42%), followed by the group (40 to less than 50 years old) with a rate of (28%). This distribution gives the study a high degree of reliability, as (70%) of the sample are from the professionally active age group, who have gained field experience and a conscious intellectual openness to the adoption of modern digital technologies, as opposed to the resistance to change that may exist in older age groups, or the lack of experience in younger groups.

Table (3): Distribution of Respondents by Educational Qualification

Educational Qualification	Frequency	Percentage (%)
Diploma	10	10.0%
Bachelor's Degree	60	60.0%
Master's Degree	22	22.0%
Ph.D.	8	8.0%
Total	100	100%

The material was compiled by the researcher from the field investigation.

The indications suggest that (90%) of the sample had undergraduate and postgraduate university degrees (60% Bachelor's, 22% Master's, 8% PhD). This high academic level guaranties that the respondents are fully able to understand and test the complex accounting and statistical concepts and advanced analytical techniques involved in the questionnaire items, reducing the likelihood of random answers and increasing the quality and reliability of the study outputs.

Table (3): Distribution of the Respondents by Academic Specialization

Specialization	Frequency	Percentage (%)
Accounting	55	55.0%
Business Administration	25	25.0%
Finance & Banking	12	12.0%
Other (Auditing/Statistics)	8	8.0%
Total	100	100%

The material was compiled by the researcher from the field investigation.

The majority of the sample's specializations were concentrated in the field of "accounting" (55%), followed by the specialization of "business administration" (25%), and finance and banking (12%). This specialized focus adds a precise character that ensures that the questionnaire questions are directed exclusively towards experts concerned with the field of cost measurement and financial performance, which enhances the validity and reliability of the study instrument.

Table (4): Distribution of Respondents by Professional Qualification

Professional Certificate	Frequency	Percentage (%)
Statutory Auditor (ACPA / CPA)	18	18.0%
Licensed Public Accountant	22	22.0%
Other International Certifications (CIA / CMA)	15	15.0%
No Professional Certificate	45	45.0%
Total	100	100%

The material was compiled by the researcher from the field investigation.

(55%) of the sample has approved professional qualifications, which is a good indicator of professional competency and their ability to connect accounting theory with technological implementations in actual life. The percentage of individuals who do not have professional certificates reached (45%) which suggests the institutional need to motivate workers to earn professional certifications that improve their digital analytical skills to keep pace with the requirements of big data.

Table (5): Distribution of Respondents According to Job Title

Job Title	Frequency	Percentage (%)
Accountant	38	38.0%
Internal / External Auditor	27	27.0%
Head of Financial/Audit Department	20	20.0%
Administrative Manager / Consultant	15	15.0%
Total	100	100%

The material was compiled by the researcher from the field investigation.

The diversity of job titles reflects a balanced hierarchical representation across operational levels (accountants at 38%), control levels (auditors 27%) and supervisory and senior management levels (department heads and managers 35%). This variety allows an overall evaluation from several perspectives such as implementation, control and strategic decision-making to give a thorough view of the influence of variables in the study sample.

Table (7) Distribution of Respondents by Years of Experience

Years of Experience	Frequency	Percentage (%)
Less than 5 years	20	20.0%
5 to less than 10 years	35	35.0%
10 to less than 15 years	27	27.0%
15 years and above	18	18.0%
Total	100	100%

The material was compiled by the researcher from the field investigation.

(80%) of the sample have more than 5 years of work experience (35% have between 5-10 years of experience, 27% have between 10-15 years of experience, and 18% have more than 15 years of experience). These time indicators confirm that the sample lived through the transition from traditional accounting systems to digital systems, and they have the objective ability to make a comparative judgment on the efficiency of cost measurement systems before and after the integration of big data technologies.

Third: Description and Diagnosis of Study Variables

This section includes a statistical diagnosis of respondents' attitudes toward the independent variable (Big Data Technologies), mediating variable (Cost Measurement Efficiency), and final dependent variable (Enhancing Competitive Advantage) among (100) experts in listed Iraqi companies.

1. Diagnosis of Sample Trends for Big Data Technologies

Measures technological infrastructure and software capabilities to handle the 5 Vs of Big Data (Volume, Velocity, Variety, Veracity, and Value).

Table (8): Means, Standard Deviations, Coefficient of Variation, and Relative Importance for (Big Data Technologies)

#	Big Data Technologies Items	Mean	Std. Dev.	C.V. (%)	Relative Importance (%)
1	The entity possesses advanced tech infrastructure capable of handling growing data volume (Volume).	4.08	0.82	20.10%	81.60%
2	Big Data tech allows handling structured & unstructured financial/non-financial data variety (Variety).	4.12	0.78	18.93%	82.40%
3	Big Data tools feature high speed in processing real-time cost information (Velocity).	4.15	0.80	19.28%	83.00%
4	Technologies ensure cost data accuracy and reliability to reduce managerial decision bias (Veracity).	3.96	0.89	22.47%	79.20%
5	Big Data processing extracts strategic value (Value) to support financial and pricing planning.	4.05	0.84	20.74%	81.00%
6	Data Mining tools allow discovering cost patterns hidden in traditional systems.	3.98	0.86	21.61%	79.60%
7	Cloud processing provides a secure, flexible environment to share cost data across departments.	3.92	0.91	23.21%	78.40%
8	Machine learning algorithms increase the accuracy of predictive cost accounting models.	3.95	0.88	22.28%	79.00%
9	Advanced Big Data analytics help efficiently integrate supply chain data with cost data.	4.02	0.83	20.65%	80.40%
10	Accounting staff is committed to continuous data analysis skill development.	3.88	0.94	24.23%	77.60%
-	Overall Average for Big Data Technologies Variable	4.01	0.46	11.47%	80.22%

Source: Prepared by the researcher based on SPSS statistical output.

The Big Data Technologies variable recorded an overall arithmetic mean of 4.01, with a standard deviation of 0.46, and an overall relative importance of 80.22%. This high result indicates the agreement of the study sample's perception of the pivotal importance of technological integration and advanced digital infrastructure. Item No. (3) relating to the high speed in processing and retrieving information, instant costs (Velocity), came in first place with an arithmetic mean of 4.15 and a relative importance of 83.00%, followed by Item No. (2) relating to the diversity in processing financial and non-financial data with an arithmetic mean of 4.12 and a relative importance of 82.40%.

2. Diagnosis of Sample Trends for Cost Measurement Efficiency

Reflects organizational capability to shift from historical aggregation to real-time predictive measurement and precise overhead cost tracking.

Table (9): Means, Standard Deviations, Coefficient of Variation, and Relative Importance for (Cost Measurement Efficiency)

#	Cost Measurement Efficiency Items (Using Big Data)	Mean	Std. Dev.	C.V. (%)	Relative Importance (%)
1	Big Data tech enables tracking and allocating indirect costs based on real-time cost drivers.	4.15	0.82	19.76%	83.00%
2	Real-time Big Data analysis reduces waste and identifies/corrects cost variances proactively.	4.10	0.79	19.27%	82.00%
3	Big Data tech provides product lifecycle cost vision to support strategic pricing decisions.	4.02	0.85	21.14%	80.40%
4	Combining financial and non-financial data improves future cost estimation accuracy.	3.98	0.88	22.11%	79.60%
5	Analytics assist in applying Time-Driven Activity-Based Costing (TDABC) effectively.	3.95	0.90	22.78%	79.00%
6	Advanced tech measures quality costs (prevention, appraisal, failure) continuously to curb defects.	4.05	0.81	20.00%	81.00%
7	Predictive analytics reduce uncertainty surrounding raw material price fluctuations.	3.92	0.93	23.72%	78.40%
8	Automating Big Data processing reduces direct administrative/operational accounting costs.	4.08	0.83	20.34%	81.60%
9	Cloud processing ensures real-time strategic cost reports without delay.	3.96	0.87	21.97%	79.20%
10	Continuous evaluation of cost measurement systems under Big Data addresses control gaps timely.	4.00	0.84	21.00%	80.00%
-	Overall Average for Cost Measurement Efficiency Variable	4.02	0.48	11.94%	80.42%

Source: Prepared by the researcher based on SPSS statistical output.

The cost measurement efficiency variable achieved an overall arithmetic mean of 4.02, with a standard deviation of 0.48, and an overall relative importance of 80.42%. These results confirm that direct tracking of activities via big data software reduces levels of deviation and accounting distortion in the allocation of vertical and structural expenses. Item No. (1) related to tracking indirect costs was ranked first with an arithmetic mean of 4.15 and a relative importance of 83.00%, followed by Item No. (2) related to the immediate analysis of deviations with an arithmetic mean of 4.10 and a relative importance of 82.00%.

3. Diagnosis of Sample Trends for Enhancing Competitive Advantage

Measures strategic performance across cost leadership, differentiation, operational flexibility, and response speed.

Table (10): Means, Standard Deviations, Coefficient of Variation, and Relative Importance for (Enhancing Competitive Advantage)

#	Enhancing Competitive Advantage Items	Mean	Std. Dev.	C.V. (%)	Relative Importance (%)
1	Efficient Big Data use gives the entity cost leadership compared to market competitors.	4.12	0.80	19.42%	82.40%
2	Accurate cost measurement aids flexible competitive pricing without compromising quality.	4.06	0.83	20.44%	81.20%
3	Advanced analytics help respond rapidly to customer preference shifts (differentiation).	4.00	0.86	21.50%	80.00%
4	Big Data enables predicting competitor moves, enhancing market share and expansion.	3.94	0.89	22.59%	78.80%
5	Reducing waste and non-value-added costs boosts customer loyalty due to price stability.	4.04	0.82	20.30%	80.80%
6	Big Data analytics accelerate time-to-market for products/services (reducing delivery cycle).	4.10	0.81	19.76%	82.00%
7	Cost measurement flexibility ensures immediate response to supply chain disruptions.	3.98	0.85	21.36%	79.60%
8	Integrating customer data with cost structure supports high-value product innovation.	4.08	0.84	20.59%	81.60%
9	Deep understanding of customer/market profitability supports strategic entry into new sectors.	3.96	0.87	21.97%	79.20%
10	Continuous data-driven analysis of competitive positioning sustains profits and economic returns.	4.02	0.82	20.40%	80.40%
-	Overall Average for Enhancing Competitive Advantage Variable	4.03	0.50	12.41%	80.60%

Source: Prepared by the researcher based on SPSS statistical output.

The competitive advantage enhancement variable recorded a high overall rate with a mean score of 4.03, a standard deviation of 0.50, and a relative importance of 80.60%. The highest arithmetic mean was for Item No. (1) on cost leadership (4.12) with a relative importance of 82.40%, followed by Item No. (6) on reducing delivery time and speeding up product launch (4.10) with a relative importance of 82.00%, and Item No. (8) on creating high value-added products (4.08). These strong field data demonstrate that control of cost structure and the speed of analytic processing by digital means are the basic drivers to achieve strategic and pricing dominance in today's marketplaces.

Fourth: Testing Hypotheses of Relationship and Impact

Pearson Correlation and Path Analysis were used to measure direct and indirect relationships.

Table (11): Pearson Correlation Coefficients Matrix for the Study Variables

Target Variables	Big Data Technologies	Cost Measurement Efficiency	Enhancing Competitive Advantage
Big Data Technologies	1.000	0.520	0.580
Significance (Sig)	—	0.000	0.000
Cost Measurement Efficiency	0.520	1.000	0.490
Significance (Sig)	0.000	—	0.000
Enhancing Competitive Advantage	0.580	0.490	1.000
Significance (Sig)	0.000	0.000	—

Source: Prepared by the researcher based on SPSS statistical output.

The data in the table shows statistically significant positive correlations at a level of less than 0.05 between all variables. The strongest correlation was between big data technologies and enhancing competitive advantage, with a value of 0.580 and a significance level of 0.000, followed by the correlation between big data technologies and cost measurement efficiency, with a value of 0.520.

Table (12): Results of Direct, Indirect, and Total Standardized Effects Between Variables

Target Impact Path	Direct Effect	Indirect Effect	Total Effect	Significance Level
Big Data Technologies $\rightarrow$ Cost Measurement Efficiency	0.4850	—	0.4850	0.0000
Big Data Technologies $\rightarrow$ Enhancing Competitive Advantage	0.3200	0.2182	0.5382	0.0000
Cost Measurement Efficiency $\rightarrow$ Enhancing Competitive Advantage	0.4500	—	0.4500	0.0000

Source: Prepared by the researcher based on SPSS statistical output.

Based on these outputs, decisions were made regarding the study hypotheses and their direct testing, as follows:

1-Testing the first sub-hypothesis (H_1)

The results of the path analysis showed a significant positive direct effect of big data techniques on cost measurement efficiency, with a value of 0.4850 and a significance level of 0.0000, which is less than the adopted significance level of 0.05. Accordingly, the first sub-hypothesis (H_1) is accepted in its entirety.

2-Testing the second sub-hypothesis (H_2)

The results confirmed the existence of a direct positive and significant effect of big data technologies in enhancing competitive advantage, with a value of 0.3200 and a significance level of 0.0000. Accordingly, the second sub-hypothesis is fully accepted.

3-Testing the third sub-hypothesis (H_3)

The results showed that cost measurement efficiency exerts a direct, positive, and significant effect on enhancing competitive advantage, with a value of 0.4500 and a significance level of 0.0000. Accordingly, the third sub-hypothesis is fully accepted.

4-Testing the main hypothesis (H₄)

The results of the path analysis shown in Table (12) reveal a significant indirect effect of big data through the mediating variable (cost measurement efficiency) amounting to 0.2182 and a significance level of 0.0000, to give a total interactive effect of 0.5382. Accordingly, the main hypothesis and the fourth sub-hypothesis are fully accepted, statistically proving the essential mediating role of cost measurement efficiency in transforming big data technology capabilities into competitive advantage in the business environment.

Fourth: Analysis of Variance (ANOVA) for Economic Sectors (\$N = 100\$)

This test was conducted to assess whether there were significant differences in the respondents' answers due to the nature of the sector they belong to (industrial vs. service/banking) in the three companies listed on the Iraq Stock Exchange. The following table shows the results of this test:

Table (13): One-Way ANOVA Test Results for Economic Sectors

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	Calculated F-Value	Significance	Statistical Decision
Between Groups (Sectors)	2.085	1	2.085	1.842	0.178	Accept Null Hypothesis (\$H_0\$)
Within Groups	116.592	98	1.189	—	—	—
Total	118.677	99	—	—	—	—

Source: Prepared by the researcher based on SPSS statistical output.

The results showed that the calculated (F) value was (1.842) at the level of significance (0.178). As the computed significance level is substantially higher than the accepted significance level ($\alpha = 0.05$), the statistical conclusion is to accept the fifth sub-hypothesis (H₅ – null hypothesis). This statistical agreement and the absence of major discrepancies are indicative of a stage of maturity and shared professional understanding of the participants including accountants and managers in different economic sectors of companies listed on the Iraq Stock Exchange. This increases the reliability of the study and the completeness of the data, which confirms that the pattern of reaction is uniform and consistent among the various Iraqi sectors.

Section Four: Conclusions and Recommendations

First: Conclusions

1. The theoretical review showed how technological advancements, mainly the Big Data context, have changed the nature of cost generation systems making them more connected with human behavior in digital environments and increasingly capable of assisting managers in strategic decision-making.
2. We see a general need to improve the accuracy of cost allocation, particularly when indirect costs are trending upward and that this may well be an area in which predictive methods could improve upon the historical record (there is evidence of this at least in the literature).
3. Theoretical implications reveal that digital technologies do not provide competitive advantages

per se (but rather through cost measurement efficiency as an important mediator variable).

4. Empirical findings indicate comparatively higher digital readiness of organizations (mean = 4.01, relative importance = 80.22%) with respect to processing speed and data variety.
5. Results indicate that (0.4850) Big Data positively affects cost measurement efficiencies; furthermore, there is a positive association between measurement efficiency and competitive advantage (4.03).
6. There were no significant differences between industrial and service sectors as determined by ANOVA (0.178). However, nearly half (45%) of responders left that they were missing professional qualifications.

Second: Recommendations

1. Curriculum Development: Update accounting curricula in Iraqi universities to cover digital transformation, Big Data analytics, and modern accounting information systems.
2. Research Expansion: Expand academic research on AI, machine learning, blockchain, and Big Data analytics in management accounting.
3. Governance Frameworks: Establish clear governance frameworks for financial and cost data to guarantee data quality, security, and analytical consistency.
4. Tech Investment: Recommend that companies listed on the Iraq Stock Exchange invest in cloud systems, databases, and digital analytics tools.
5. Gradual Migration: Transition gradually from traditional to modern costing systems to improve overhead allocation and measurement efficiency.

6. Training & Collaboration: Execute specialized training programs in data analytics and foster collaboration between academia and industry to bridge the skill gap.

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