Information Sciences Letters

Volume 12
Issue 6 *Jun. 2023*

Article 45

2023

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Information Sciences Letters
An International Journal

http://dx.doi.org/10.18576/isl/120645

The Impact of Big Data Analytics on Investment Efficiency and Financial Performance: Evidence from Saudi Stock Market

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Received: 22 Mar. 2023, Revised: 22 Apr. 2023, Accepted: 1 May 2023.
Published online: 1 Jun. 2023.

Abstract: The paper investigates the determinants of adopting big data analytics (BDA) in the Saudi environment according to vision 2030, in addition to the impact of BDA on both investment efficiency and financial performance, we analyzed the academic accounting literature and provide a theoretical framework for each variable. Furthermore, to achieve our research objectives we developed three hypotheses and tested them through an empirical study based on three statistical models; our sample consisted of the largest 50 companies operating in the Saudi stock market for five years (2017-2021). Going further, our findings illustrated that (1) Firm Size, Cash Flows, Growth Opportunities, and Dividend Policy have a positive significant impact on the adoption of big data analytics (2) Leverage and Working Capital have a positive significant impact on the adoption of big data analytics (3) There is a positive impact of the adoptions of big data analytics on investment efficiency (4) There is a positive impact of the adoptions of big data analytics on the financial performance.

Keywords: Big Data Analytics, Investment Efficiency, Financial Performance, Saudi Stock Market.

1. Introduction

"Big Data" in general according to accounting thought is a collection of unstructured, semi-structured, and structured data collected by corporations that can be generated for financial information and used in predictive modeling, machine-learning projects, and analytics accounting applications that help managers in the decision-making process [1]. Moreover, electronic systems that generate, process, and store big data have become a vital element of data management architectures in corporations, combined with tools that support big data analytics purposes. Big data is often characterized by: (a) the huge amount of data in many business sectors; (b) the large variety of data types frequently stored in data systems; and (c) the velocity at which much of the information is created, collected, and processed. Moreover, several types of data are created and available with the rapid advance of information technologies, and nowadays data is seen as one of the most valuable elements in managing business systems. In the age of technology, “Big data” became one of the most recent technical issues. Millions of events and transactions occur every minute. The accounting field is involved profoundly in the calculation of big data transactions. As a result, hundreds of millions of accounting transactions occur daily in the business world. thus, financial professionals and analysts consider it an emerging issue of the data management and analytics of different accounting aspects. where big data has a significant impact on accounting services. Therefore, identifying the accounting issues where big data analytics (BDA) has a considerable influence is also an essential issue to investigate with the influences. Big data analytics has gained more attention from both industry and academia because of the growing demand for handling and understanding trends in huge datasets. [2]

Capital markets and technological evolution have become associated with every financial activity in the past two decades. Big data analytics has become an important part of the financial industry and will guide future innovation [3]. In this sense, managing and analyzing this data is also considered an important element in these financial services. Any damage to the data can cause serious problems for that specific industry. Financial analysts use many types of data to make investment decisions. In addition, financial industries use "Big Data" through different predictive analyses and control spending patterns to improve decision-making models. furthermore, the managers can decide which financial services to operate [4]. Hundreds of millions of data are transmitted between corporations and stakeholders. That is why

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"Big Data" is receiving more attention in the accounting services field, where information affects the success and production elements. It has been playing an increasingly important role in increasing our understanding of capital markets.

Going further, Recent developments in cyber systems, sensor networks, and the spread of the Internet of Things have increased the collection of data (including accounting reports, social media, finance, education, etc.) to a massive scale [1,5]. Moreover, the data generated from social media, financial records, etc. are inherently fuzzy due to inconsistency and incompleteness. Thus, understanding such huge amounts of data requires advanced analytical methods for predicting future courses of action and efficiently reviewing with high accuracy and advanced decision-making techniques [2] As the massive amount, speed, and variety of data increases, so does the uncertainty inherent within, resulting in a low degree of confidence in the analytics process and decision-making. In comparison to traditional techniques in data analysis, artificial intelligence (including natural language processing, machine learning, and computational intelligence) prepare faster [3], more accurate, and more scalable results in data analytics. Advanced data analysis methods can be applied to convert big data into smart data for obtaining critical information concerning large datasets [2,6] So, Big data makes it possible for managers to base judgments on logic rather than Personal experience [7]. thus, the article continues as follows: part two reviews accounting literature, focusing on big data analytics determinants, investment efficiency, and financial performance then hypotheses development. Part three develops the research model, part four Results, and part five Conclusion.

2. Literature Review and Hypotheses Development:

2.1. Saudi Stock Market and Vision 2030:

The main authority that controls organizations and regulates the stock and capital market in Saudi Arabia is “Capital Market Authority - CMA”.

2.1.1. The Establishment of the Saudi Stock Market:

The Capital Market in Saudi Arabia unofficially started in the early fifties of the last century and continued to work, until the kingdom set its basic rules in the eighties. The law of Capital Market is promulgated and according to Royal Decision M/30 dated 1424H, which officially established CMA into existence [8], The CMA is a government authority with full legal, financial, and administrative independence. The CMA’s objectives are to develop, organize and regulate the Capital Market by issuing required regulations and rules for adopting the Capital Market Law. The basic functions are to create an appropriate investment market and reinforce transparency and disclosure manners in all operated corporations and protect the owners and all stakeholders from illegal acts, The Law provides for the creation of the “Saudi Stock Exchange” as a Joint Stock corporation that works and operates as the only authorized body to deal with the trading of stocks and securities in Saudi Arabia. The exchange deals operated through "*Saudi Stock Exchange - Tadawul*", to continuously improve a full-fledged stock market that provides diverse and comprehensive financial services to compete internationally.

2.1.2. Saudi Vision 2030:

Since the launch of Vision 2030, Saudi Arabia has built a foundation, during which major reforms have been made in the private and public sectors' operating model. This laid the foundations for future success. The vision was cascaded into long-term strategic objectives; one of them is "Thriving Economy" and this objective contains many programs. Furthermore, one of these programs is the “Financial Sector Development Program". The Financial Sector Development Program aims to create an effective and diversified financial sector to support Saudi Arabia's economy and diversify its sources of income and investments. The aim is to boost financial sector authorities and develop the financial market to become an advanced capital market. So, listed under this Program’s umbrella are several sub-sectors, including insurance, banking, investment, and stock markets. [9]

2.2. Background of BD and BDA in Accounting:

Big Data (BD) concept can be defined as an approach to process, manage, and analyze five dimensions. In the academic literature, they are known as the “5 Vs” [10] (A) Volume; With continuous technology innovation, the daily quantity of data created grows exponentially. Every minute on the websites the volume of data created is more than the storage capability of the overall internet 30 years ago. (B) Variety; The sources of big data are varied and new. Data is created from different digital applications and platforms. For example, BD can take the type of updates, messages, images posted on social media, GPS signals, and more. (C) Velocity; The speed of data generation is even more important than the size, due to the business environment becoming more competitive, and one of the key elements for achieving success is managers' ability to make decisions faster. Where data are available just in time. (D) Veracity; data must have quality, and the source must be trusted. (E) Value; Generating economic profits and benefits from big data has

enormous importance. This value is associated with the corporation's ability to make better decisions.

Nowadays, big data analytics (BDA) is a widespread topic among practitioners and scholars. [5,6,9,10] Where, the concept of BDA is defined by the literature as a comprehensive approach to managing, processing, developing, and analyzing the data-related dimensions [3] such as variety, veracity, velocity, volume, and value, to develop ideas for achieving sustained value, creating competitive advantages, and measuring financial performance. Moreover, we can call BDA a new Approach to knowledge assets. So, the era of "Big Data" is coming, and traditional data analytics may not be able to deal with such huge quantities of data [11]. The main argument that arises now is how to establish a high-performance platform to efficiently handle "big data" and how to develop an appropriate mining algorithm to find useful uses for big data [12]. To handle the problems of analyzing large-scale financial data, just some little efficient methods, such as data condensation, divide and conquer, grid-based approaches, sampling, distributed computing, incremental learning, and density-based approaches, have appeared. [1]. Moreover, there are three themes for Big Data Analytics Capability (BDAC) [13] the first theme is data analytics management capability (BDAMC), the second theme is big data analytics technological capability (BDATC) and contains connectivity, comparability, and modularity, the third theme is big data analytics personal capability (BDAPC) and contains technical skills, technical management knowledge, and business knowledge.

With current advanced analytical technology, we can get developed insights from any type of data [2,4,7]. advanced Analytics is a combination of statistics and math adapted to huge amounts of data. Big Data analytics (BDA) refers to the use of math, statistics, and arithmetic to analyze huge amounts of unstructured data. Where Big Data without analytics is just a group of data, thus integrating the two creates a set of methods that help decision-makers in getting remarkable insights and using data in business knowledge [7]. In accounting practices and professionals, the main purpose of big data and its analytics is to gather, organize, and tap data from a variety of sources in real-time to acquire new business insights [5,9]. for example, anyone who has authority can access up-to-the-minute data from any location with a network connection, rather than relying on monthly financial reports for their assessments. [7]

A new stream of research argues that creating value from big data analytics is a result of the spread use of these technologies in operations, and therefore requires a firm-wide big data analytics ability to be improved, where [10] investigated the elements that affect the application of BDA by corporations, based on three features: organizational, technological, and environmental context, and argued that management support, relative advantage, complexity, technology readiness, compatibility, and competitive pressure influence the adopters of BDA, whereas competitive pressure, complexity, and relative advantage influence the non-adopters of BDA.

In addition, [14] tested the organizational adoption interest of big data and extends the literature of BDA, then addressed the factors determining corporations' intention to adopt BDA in their operations, this paper classifies factors into three types: organizational, technological, and environmental factors, and argued that perceived benefits and the support of managers can influence the adoption intention. In addition, environmental factors, like government policy and competitors' adoption can significantly moderate the relation between the adoption intention and driving factors. In this way, [15] analyzed elements affecting IT practitioners' behavioral interest in applying BDA using a combination of the Unified Theory of Acceptance, Initial Trust Model, and Use of Technology and Task-Technology Fit Model acceptance models. Moreover, showed that the main element that determines behavioral interest in applying BDA in government authorities is the argument that the technology will generate great results and increases performance expectation. However, [16] argued that big data makes an opportunity for corporations to create business value and increase competitiveness. Many corporations have made BDA a top priority. However, the literature showed that management is still unready to change their work themes to employ this new technology. furthermore, empirical evidence on what determines their application of BDA in management decision-making is still rare. In addition, illustrated that the essential elements across countries linking BDA in making the decision are data quality, technology readiness, managers' knowledge, and organizational expectations. Furthermore, [17] identifies the objectives of Big Data applications within the services and manufacturing sectors in India. And showed that the following elements are very important for both sectors: relative advantage, compatibility, complexity, relative advantage, organizational size, top management support, relative advantage, vendor support, relative advantage, and data privacy. And argued that, most of the academic literature on BDA has focused mainly on operational and technical issues, and only a few papers have illustrated the applying BDA from an organizational perspective. No study has produced a satisfactorily comprehensive evaluation of BDA adoption's determinants. Then, [18] investigated how the managerial decision-making process was influenced by BDA, the quantitative skills of senior and middle managers. The results showed that BDA creates an incentive for managers to base more of their decisions on analytic insights. reveals that contrary to mainstream perceptions, managers in smaller corporations are more capable in terms of quantitative skills, and they are significantly more likely to base their decisions on analytics than managers in large organizations. In addition, suggest that smaller firms may owe some of their analytic advantages to the fact that they have managers who are closer to their analysts – and analytics more generally.

Going further, [19] illustrated the improvement of the Internet of Things and accounting computing methods, in addition, the volume of data from accounting information systems has been increasing rapidly. So, BDA has been a major technology to authorize intelligent systems, moreover, provided a comprehensive review of the conceptual framework such as the concept of big data, model-driven, and data methodologies. Moreover, argued that BDA is becoming a major technology method to improve decision-making processes and forecasting in manufacturing systems. BDA is a key future perspective in both industrial and academic societies. In addition, [20] argued that Data availability and accessibility are changing Information Systems research' nature. Such research mainly uses large datasets, which may include unstructured and structured data, from several data platforms. Then, attempted to address this gap and provide evidence around the methodological applications required in BDA research to be useful in information systems research. Moreover, concluded that information systems literature with BDA is still at the beginning stage. There are a lot of scopes for it to mature in the next years and to develop a comprehensive theoretical framework.

On another side, [21] showed that big data analytics capability was found to have a positive association with all the main dimensions with BDA talent capability emerging as the strongest. This argument suggested that greater gains in overall BDAC could be created by big data analytics talent capability, which is evident in 'born-through-analytics (BTA) corporations' like Amazon, Twitter, and Facebook and their well-developed recruiting approaches for analytics talent. Finally, the process of analyzing big data in accounting from its generation to the preparation of financial reports can be summarized as follows: (a) Data sources level (b) Big data management level (c) data analysis level (d) big data analysis capabilities level (d) value creation level.

Grounded on past research, which argued that adopting BDA in businesses requires many operational characteristics to get the best of it [22], we reviewed this point as follows:

2.2.1. BDA and Firm Size (FS):

Size is the most element that can affect the adoption of BDA because of the huge data generated every financial period, and the comparison between cost and benefits from this adoption, where we can refer to firm size by the total assets. Furthermore, Empirical accounting literature illustrated a positive relationship between Big Data Analytics and firm size [3,10,16,19,23] based on that Large-sized corporations are associated with many stakeholders. especially current and potential investors in the stock market, in addition to the fact that the financial position of these corporations makes the advantages of expanding BDA with a return greater than its cost, unlike small corporations. Whereas another stream of the literature illustrated a negative relation [9,18]. Nevertheless, [20] proved that there is no relation. Thus, the following hypothesis can be developed:

H.1 (a) "FS has a significant impact on Adopting BDA".

2.2.2. BDA and Leverage (LEV):

Leverage is mainly considered as a ratio of financial stability and the ability of any company to face its liabilities, and BDA can make it easy to track all elements and factors regarding leverage and make it possible to control it, and we can refer to leverage by total liabilities over Total shareholders' equity. Furthermore, Empirical accounting literature illustrated a positive relationship between Big Data Analytics and firm size [21,24,25], based on that high-leverage corporations seek to increase BDA as one of the explanatory mechanisms to explain this increase in the ratio of Leverage, and they need to highlight their financial ability to fulfill their obligations through their plans. Where another stream of literature illustrated a negative relation [3,10] corporations with a high-leverage rate face a rise in risks, especially operational ones, which prompts corporations to refrain from disclosure until they hide the current situation. Nevertheless [26] proved that there is no relation. Thus, the following hypothesis can be developed:

H.1 (b) "LEV has a significant impact on Adopting BDA".

2.2.3. BDA and Working Capital (WC):

Working capital affects many aspects, such as sustainable long-term growth. Simply, working capital is the fund available to meet current, short-term liabilities. Furthermore, Empirical accounting literature illustrated a positive relationship between Big Data Analytics and Working Capital [12,23]. Whereas another stream of the literature illustrated a negative relation [7,19]. Nevertheless [6] proved that there is no relation. Thus, the following hypothesis can be developed:

H.1(c) "WC has a significant impact on Adopting BDA".

2.2.4. BDA and Operating Cash Flow (OCF):

Cash flows are incoming and outgoing cash. where the cash flow information provides a basis for evaluating the ability of companies to generate cash, and the free cash flow theory indicates the preference of the company's management to

maintain high percentages of cash, especially with the increase in the rates of investment and financing cash flow commitments. Furthermore, Empirical accounting literature illustrated a positive relationship between Big Data Analytics and Operating Cash Flow [3,20]. Whereas another stream of the literature illustrated a negative relation [18,23]. Nevertheless [10] proved that there is no relation. Thus, the following hypothesis can be developed:

H.1(d) "CF has a significant impact on Adopting BDA".

2.2.5. BDA and Growth Opportunity (GO):

The growth opportunity rate is the volume of change in the net profit achieved at the end of the fiscal year compared to the previous fiscal year, concerning the total economic resources. Furthermore, Empirical accounting literature illustrated a positive relationship between Big Data Analytics and Growth Opportunity [3,10,19] based on the desire of the company's management to achieve the maximum possible benefit from future growth opportunities by using BDA. Whereas another stream of the literature illustrated a negative relation [16,20] Nevertheless [23] proved that there is no relation. Thus, the following hypothesis can be developed:

H.1(e) "GO has a significant impact on Adopting BDA".

2.2.6. BDA and Dividend (DIV):

A dividend refers to the distribution of a corporation's earnings to its stockholders; Dividends are mainly distributed every three months (quarterly) and may be paid as real cash or reinvestment in more stocks. Furthermore, Empirical accounting literature illustrated a positive relationship between Big Data Analytics and Dividend [23,26]. Whereas another stream of the literature illustrated a negative relation [10,15]. Nevertheless [3] proved that there is no relation. Thus, the following hypothesis can be developed:

H.1(f) "DIV has a significant impact on Adopting BDA".

2.3. BDA and Investment Efficiency (IE)

Investment decisions are the essence of the modern business environment, with its effects, whether positive or negative, on the wealth of investors, and the various groups of stakeholders associated with companies. In the globalization era and considering the competition and convergence of financial performance within the financial markets, investment decisions have become extremely difficult and linked more than ever to data and information, whether historical or future. A recent trend appeared in the accounting literature to study the impact of many factors on the efficiency of investment decisions and to determine the scientific framework for it, especially as it is linked to ensuring continuity and Corporate Survive [19], And since the information has an impact on directing stakeholders, especially investors, whether current or potential and affecting the flow of capital, whether positively or negatively, its role has emerged in influencing the efficiency of investment decisions, which made studying and analyzing the relationship between information and investment decisions a subject of research interest on the International level, especially accounting studies related to the efficiency of capital markets.

The accounting literature offers many perspectives that tried to understand the relationship between BDA and Investment Efficiency [11,21], these perspectives are illustrated within stakeholders' theory, agency theory, pecking order theory, and Legitimacy theory. Going further, BDA is now considered a major differentiator between high-efficiency and low-efficiency firms in terms of long-term investment as it allows firms to become forward-looking and proactive [3], where [4] suggests that through the use of big data analytics, Companies can sense future threats and opportunities, in addition, generate a critical vision, and adjust their operations according to trends in the business environment. So, the main competitive differentiator that BDA provides depends on the fact that it can provide better-informed decision-making. Where, [19] explained that the efficiency of investment decisions refers to the implementation of investment projects and expansions by companies with a positive net present value, assuming that there are no fluctuations in the money market (Market Frictions) that affect the possibility of achieving the target performance. Where investment decisions have the capacity of efficiency when the actual investment value matches the expected investment value in the same period considering the available growth opportunities, but in the event of a decrease or increase in the actual investment value than expected, this value indicates the inefficiency of investment decisions. Going further, the phenomenon of information asymmetry arises from the agency between management and investors because of the information gap between what is available to both categories and the consequent decisions, whether administrative or investment. The issue of information asymmetry is often accompanied by the hypothesis of administrative opportunism simply Impression Management. [22] Indicates that the most important reason for the inefficiency of investment decisions is the phenomenon of information asymmetry. Where [27] examined the forms of benefit that corporations can generate from BDA investments, the direct effect it has on investment efficiency and financial performance, and the mediating impact of market performance. Based on the resource-based view theory and

concluded that the value generated from investments in BDA archives benefits according to the financial performance and provides evidence of the lack of a market performance mediation effect. Moreover, the accounting literature agreed that there are two dimensions to the inefficiency of investment decisions [28], where the first dimension is under-investment, when corporations are reluctant to implement projects with a positive net present value, and the second dimension is an increase in investment. Over-investment is when corporations implement projects with a negative net present value. In addition, [22] indicates that Investment Managers recently are taking their decisions more and more on real-time insight driven by big data analytics and are steering a growing volume of initiatives in this direction to improve investment efficiency.

Most research - till now - on big data analytics and its relationship with investment efficiency come from consultancy firms, and case studies, which fail to create comprehensive applied results from large-scale analyses or business environments, in addition to the lack of theoretical framework [4], Thus, the following hypothesis can be developed:

H.2 "BDA has a significant impact on IE".

2.4. BDA and Financial Performance (FP)

BDA is now considered a major game-changer in the recent financial environment by enabling improved business effectiveness and efficiency because of its high operational and strategic change. The current literature on BDA has referred to a positive relationship between BDA and firm performance [3].

From a business perspective, corporations are increasingly trying to integrate business processes into information systems applications and build fact-based technologies for decision-making in an optimal time [10]. To create and enhance competitive advantage, improving BDA ability is a major mission because it is rapidly changing the way that corporations understand their environment, thus becoming an important part of corporations' business strategies and financial performance plans. Simply, BDA provides the best opportunities for developing the performance and business processes of corporations.

Despite many promises from BDA, there has been significantly less evidence on how organizations need to be structured to create business value from such investments, and a limited understanding of the interplay of elements that achieves financial performance development [4]. Moreover, recent academic research has indicated that there is still a sizeable volume of firms that fail to capture value from their BDA investments. And [10] argue that this issue can be largely a result of the fact that most of the academic literature on BDA has been developed by consultants, furthermore [11] argue that the human factor is very important while developing analytical capabilities dynamic in nature in the process of achieving high-level performance. Where [29] aimed to analyze the relationship between the use of big data technology and the level of financial performance considering the modified effect of the accounting information system's quality on that relationship. And argued that there is a statistically significant relationship between the development of the accounting information system and the improvement of financial performance considering the big data technology using the rate of return on assets. Moreover, developing advanced analytical models and methods will reduce fraud and help in controlling financial elements.

From an empirical view, Companies are facing many difficulties in using BDA to improve performance, support decision-making processes, and extract new insights to achieve competitive advantages. These challenges are due to the corporations' inability to understand the importance of this data, and the extent of its contribution to performance development, in addition to the inability to integrate this data to exploit it in a better way and extract the maximum benefit from it [30]. In addition, many financial reports of multinational companies have presented and disclosed their experiences in the use of BDA and the extent to which it contributes to company value especially in improving operational efficiency, risk management, and innovation [31].

From another point of view [13,32] argued that BDA improves financial performance based on an empirical study, whereas [22] built a theory of big data analytics capability strategy that shows how to leverage the big data analytics capability dimensions and sub-dimensions to build an overall big data analytics capability climate. In addition, illuminates the role of RBT and entanglement view in proposing an integrated big data analytics capability' model and its overall impact on corporate performance. Where, [24] explores the relationship between BDA capabilities and the impact of these capabilities on corporate performance using integrated decision-making methodology using three MCDM tools: analytic network process, intuitionistic fuzzy decision-making trial and evolution laboratory, and simple additive weighting, were employed to evaluate the importance of BDAC and the relation of these capabilities with the corporate performance. In addition, concluded that BDA capabilities are interdependent, and BDAC is more associated with operational performance than market performance. Moreover, [10] addressed BDAC and knowledge management (KM), in addition to the impact on firm performance (FP), and concluded, corporations that improved more BDAC than others, both managerial and technological, increased their financial performances and that knowledge management orientation plays a significant role in creating the effect of BDA capabilities.

The above arguments were in the same manner as [23] showed that the field of BDA is one of the fastest-growing IT fields, and while corporations across industries are making massive investments in BDA, the body of empirical evidence for the positive impact of BDA on organizational performance is still only emerging. Therefore, recent academic research has indicated that several corporations fail to capture value from their BDA investments. Thus, the following hypothesis can be developed:

H.3 "BDA has a significant impact on FP".

3. Research Models:

This section of the research presents the regression models that we evaluated and estimated to analyze the relations between variables:

3.1. Determinants of BDA: (H.1 a,b,c,d,e,f)

$$BDA_{i,t} = \alpha + \beta 1\, FS_{i,t} + \beta 2\, LEV_{i,t} + \beta 3\, WC_{i,t} + \beta 4\, CF_{i,t} + \beta 5\, GOs_{i,t} + \beta 6\, DIV_{i,t} + \varepsilon_{i,t}$$

3.2. The impact of BDA on Investment Efficiency:

$$IE_{i,t} = \alpha + \beta 1\, BDA_{i,t} + \beta 2\, FS_{i,t} + \beta 3\, LEV_{i,t} + \beta 4\, WC_{i,t} + \beta 5\, CF_{i,t} + \beta 6\, GOs_{i,t} + \beta 7\, DIV_{i,t} + \varepsilon_{i,t}$$

3.3. The impact of BDA on Financial Performance:

$$FP_{i,t} = \alpha + \beta 1\, BDA_{i,t} + \beta 2\, FS_{i,t} + \beta 3\, LEV_{i,t} + \beta 4\, WC_{i,t} + \beta 5\, CF_{i,t} + \beta 6\, GOs_{i,t} + \beta 7\, DIV_{i,t} + \varepsilon_{i,t}$$

Were,

Big Data Analytics (BDA) = (3) more than two models for BDA (2) two models for BDA (1) Applied one model for BDA (0) Not Applied

Investment Efficiency (IE) = (Current value of Investment – Cost of Investment) / Cost of Investment

Firm Performance (FP) = Net Profit after Tax/ Total Assets

Firm Size (FS) = Natural Logarithm of total assets

Leverage (LEV) = Total liabilities / Total shareholders' equity

Working Capital (WC) = Cash-Current assets-current liabilities / Total assets

Cash Flow (CF) = (Depreciation + Earnings before interest) /Total assets

Growth Opportunities (GOs) = Tobin's Q; MV (Equity+ Liabilities) / BV (Equity + Liabilities)

Dividend (DIV) = Total distributed dividends / Total assets.

4. Results:

4.1. Testing data validity

Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test the normality of the continuous variables and whether they follow a normal distribution, both the, results showed that the probability value (P.value) or (Sig.) is less than (0.05), which means that the data does not follow a normal distribution in all variables, and this result is confirmed by measuring Skewness coefficient which does not approach zero, and (kurtosis coefficient) that does not approach (3) for most variables. To bypass this problem, the natural logarithm was for these variables so that they approach the normal distribution, and this is illustrated through the following table:

Table 1: Results of testing the Natural Distribution of the study variables

Tests of Normality						
Variable	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
IE	.146	250	.000	.935	250	.000
FP	.079	250	.001	.973	250	.000
FS	.048	250	.200*	.992	250	.171
LEV	.148	250	.000	.876	250	.000
WC	.069	250	.006	.985	250	.008

CF	.182	250	.000	.901	250	.000
GOs	.238	250	.000	.795	250	.000

The Multicollinearity was examined by measuring the Variance Inflation Factor (VIF) for each of the independent variables to examine the effect of correlation between the independent variables as shown in the following table:

Table 2: Multicollinearity Test Results

First Model

Coefficients[a]			
Model		Collinearity Statistics	
		Toler.	VIF
1	FS	.266	3.766
	LEV	.138	7.247
	WC	.874	1.144
	CF	.087	11.481
	GOs	.913	1.096
	DIV	.952	1.051

Second Model

Coefficients[a]			
Model		Collinearity Statistics	
		Toler.	VIF
2	BDA	.613	1.632
	FS	.242	4.135
	LEV	.122	8.224
	WC	.868	1.152
	CF	.083	12.111
	GOs	.906	1.103
	DIV	.947	1.056

Table (2) shows that the (VIF) value for all study variables did not exceed (10), so the study models do not have any Multicollinearity issues, the correlation between the variables is not statistically significant and very low, and this indicates the strength of the model that is used to test the effects of the independent variable on the dependent variables.

The Durbin-Watson test was also used to verify that there was no autocorrelation problem between the study variables as shown in the following table:

Table 3: Durbin-Watson Test Results

Second model

Model	Durbin-Watson
2	1.889[a]

First model

Model	Durbin-Watson
1	1.835[a]

Table (3) shows that the Durbin-Watson values fall between the upper tabular values and four minus the upper tabular values, which indicates that the study models do not have any autocorrelation problems.

4.2. Descriptive analysis of the study variables:

Table (4) shows a description of the study's continuous variables which are Investment efficiency, Firm Performance, Firm Size, Leverage, Working Capital, and Growth Opportunities.

Table 4: Descriptive Statistics of the Study Variables

Descriptive Statistics					
Variable	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
IE	250	-1.952	4.620	.97770	1.722379
FP	250	.060	.460	.21144	.078220
FS	250	3.010	14.260	8.90421	2.306637
LEV	250	2.01	9.88	4.9342	2.43623
WC	250	1.200	27.200	13.82160	5.442590
CF	250	-1.960-	45.960	17.12643	14.432142
GOs	250	2.010	9.990	4.47812	2.234092
Valid N (listwise)	250				

It is noted from table (4) that the average investment efficiency during the study period was (0.97770) and its highest percentage was (4.620) while the lowest percentage was (-1.952), and the mean for financial performance was (0.21144) with a deviation of (.078220), the highest percentage was (0.460), and the lowest was (0.060). The average firm size was (8.90421) with a deviation (2.306637). The average leverage was (4.9342) with a standard deviation of (243623), The average working capital was (3.82160) with a standard deviation (5.442590), mean cash flow (13.82160) with a standard deviation of (5.442590). The average value for growth opportunities is (4.47812) and the maximum is (9.990), while the lowest value was (2.010).

Table (5) also shows the descriptive statistics of the study (Dummy Variables), which are the stages of the firms' life cycle.

Table 5: Descriptive Statistics of Discrete Study Variables

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**no div**	55	22.0	22.0	22.0
	div	195	78.0	78.0	100.0
	Total	250	100.0	100.0	

It is clear from table (5) that the number of firms that are having dividends distributions is high and amounted to 195 firms – year (78%) compared to other firms that did not distribute dividends, which is 55 companies – year (22%).

4.3 discussion of the hypotheses testing results:

4.3.1. Correlation Analysis Results:

Pearson correlation coefficient was used to determine the strength and direction of the relationship between each stage of the firm life cycle, social responsibility, quality of receivables, and dividend policy. Table (6) shows the correlation matrix for the study variables.

Table 6: Pearson Correlation Matrix

Var.	BDA	IE	IEABS	FP	FS	LEV	WC	OCF	GO	DIV
BDA	1									
IE	.492**	1								
FP	.685**	-.218-**	-.194-**	1						
FS	.517**	-.731-**	-.487-**	.361**	1					
LEV	-.563-**	.813**	.703**	-.204-**	-.733-**	1				
WC	-.101-	.096	.087	.023	.038	.110*	1			
CF	.503**	.880**	.629**	-.215-**	-.843-**	.924**	.066	1		
GOs	.081	.023	-.014-	.133*	-.068-	-.046-	-.252-**	-.019-	1	
DIV	.100	.030	-.049-	.168**	.071	-.054-	.171**	-.046-	.055	1

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

Based on table (6) table, there is a positive correlation between big data analytics and the efficiency of the investment decision, as the correlation coefficient sign was positive, and the level of significance was less than (0.05). There is also a positive correlation between big data analytics and financial performance since the value of the correlation coefficient was 0.685) and the significance level is less than (0.05). As for the correlation between big data analytics and control variables, the results showed a positive correlation between big data analytics and each of the firm size, cash flows, growth opportunities, and dividend policy, since the correlation coefficient sign was positive and the significance level was less than (0.05), while the relationship between Big data analytics with both leverage and working capital are negative where the correlation coefficient sign is negative and its significance level is less than (0.05).

4.3.2. Multiple Regression Analysis:

Multiple regression of the study hypotheses can be illustrated as follows:

4.3.2.1. Hypothesis (1) GO has a significant impact on Adopting BDA:

The following table shows the results of multiple linear regression analysis:

Table 7: Multiple Regression Analysis for the First Model

Coefficients[a]						
BDA i,t = α +β1 FS i,t +β2 LEV i,t +β3 WC i,t +β4 CF i,t +β5 GOs i,t +β6 DIV i,t + ε i,t						
Model		Unstand. Coeff.		Stand. Coeff.	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.805	.475		1.696	.091
	FS	.195	.040	.476	4.884	.000
	LEV	-.301	.053	-.774	-5.725	.000
	WC	-.012	.009	-.068	-1.264	.207
	CF	.041	.011	.621	3.652	.000
	GOs	.029	.022	.069	1.305	. 033
	DIV	.137	.117	.060	1.167	. 025
	R	0.517				

	R^2	0.267
	Adj. R^2	0.264
	Std. Err.	0.812
	F	90.283 Sig.0.000

The previous table shows that the Adjusted R2 value is (0. 264), which reflects that the explanatory value of the model explains 26% of the changes affecting big data analytics, while the overall significance of the regression model used can be identified by the analysis of variance (ANOVA), where the F-value was (90.283) with a significance level of (0.000), which indicates the high significance of the study model and its validity to fulfill the study objective.

The results of the regression (Table 7) showed that each of the firm size, cash flows, growth opportunities, and dividend policy have a positive significant impact on big data analytics, where the regression coefficient signal (β) was positive and the p-value (Sig. = 0.000) was less than the level of significance of (0.05), while both leverage and working capital has a negative significant impact on big data analytics as the regression coefficient signal (β) was negative and the p-value (Sig = 0.000) was less than the level of significance (0.05), which proves the validity of the first hypothesis, and this is consistent with [33] which confirms that large firms have enough financial resources to perform big data analytics when compared to small firms. Therefore, the regression model of the factors affecting big data analytics can be formulated as follows:

$$BDA\,i,t\; = .805\; + \beta 1\; .195 - \beta 2\; .301 - \beta 3\; .012\; + \beta 4\; .041\; + \beta 5\; .029 + \beta 6\; .137\; +\; \varepsilon\, i,t$$

4.3.2.2. Hypothesis (2) BDA has a significant impact on Investment Efficiency:

This hypothesis aimed to test the relationship between big data analytics and investment decision efficiency. The following table shows the results of the regression analysis of the second model.

Table 8: Multiple Regression Analysis for the Second Model

Coefficients[a]						
IE i,t = α +β1 BDA i,t +β2 FS i,t +β3 LEV i,t +β4 WC i,t +β5 CF i,t +β6 GOs i,t +β7 DIV i,t + ε i,t						
Model		Unstand.Coeff.		Stand.Coeff.	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	.536	.374		1.436	.152
	BDA	.403	.050	.416	8.045	.000
	FS	.088	.033	.220	2.674	.008
	LEV	-.189	.044	-.502	-4.327	.000
	WC	-.003	.007	-.015	-.344	. 031
	CF	.009	.009	.144	1.020	.309
	GOs	.023	.017	.056	1.317	. 019
	DIV	.022	.092	.010	.243	. 018
	R	.777				
	R^2	.604				
	Adj. R^2	.592.				
	Std. Err.	.58616				
	F	52. 654 Sig. 0.000				

Table (8) shows that the Adjusted R2 value is (0. 592), which reflects that the explanatory value of the model explains (59%) of the changes affecting big data analytics, while the overall significance of the regression model used can be identified by the analysis of variance (ANOVA), where the F-value was (52.654) with a significance level of (0.000), which indicates the high significance of the study model and its validity to fulfill the study objective.

Regression results from table (8) show that big data analytics is associated with a positive significant relationship with investment efficiency, as the regression coefficient signal (β) was positive, and the p-value (Sig = 0.000) was less than the level of significance (0.05). The regression results also showed that there is a negative significant effect for leverage and net working capital on investment efficiency, while there is a positive and significant effect for each firm size, cash flows, growth opportunities, and dividend policy on big data analytics since the regression coefficient signal (β) was positive and the p-value (Sig = 0.000) was less than the significance level (0.05) which confirms the second hypothesis, and this is consistent with the study of Ferraris et al. [26] that found evidence on the positive effect of big data analytics on improving the investment efficiency.

Therefore, the regression model for the impact of big data analytics on investment decision efficiency can be formulated as follows:

$$IE\ i,t\ = .536\ + \beta 1\ .403\ + \beta 2\ .088\ - \beta 3.189 - \beta 4\ .003\ + \beta 5\ .009 + \beta 6\ .023\ + \beta 7\ .022\ +\ \varepsilon\ i,t$$

4.3.2.3. Hypothesis (3) BDA has a significant impact on Financial Performance:

Table (9) shows the results of the regression analysis for the relationship between DBA and financial performance.

Table 9: Results of Multiple Linear Regression Analysis for the Third Model

Coefficients[a]						
FP i,t = α +β1 BDA i,t +β2 FS i,t +β3 LEV i,t +β4 WC i,t +β5 CF i,t +β6 GOs i,t +β7 DIV i,t + ε i,t						
Model		Unstand.Coeff.		Stand.Coeff.	Unstand.Coeff.	Sig.
		Std. Error	Beta	Std. Error		
3	(Constant)	.113	.033		3.436	.001
	BDA	.064	.004	.770	14.396	.000
	FS	.011	.003	.320	3.758	.000
	LEV	.013-	.004	.390-	3.246-	.001
	WC	.001-	.001	.057-	1.279-	.202
	CF	.021	.001	.084	.577	. 045
	GOs	.004	.002	.122	2.778	.006
	DIV	.014	.008	.077	1.788	.025
	R	.759				
	R^2	.576				
	Adj. R^2	.564				
	Std. Err.	.051668				
	F	46.954 sign. .0000				

The previous table shows that the Adjusted R^2 value is (.564), which reflects that the explanatory value of the model is high and that most of the changes can be explained by the model used, while the overall significance of the regression model used can be identified by the analysis of variance (ANOVA), where the F-value was (46.954) with a significance level of (0.000), which indicates the high significance of the study model and its validity to fulfill the study objective.

The regression results in Table (9) show that big data analytics has a positive and significant impact on financial performance, as the regression coefficient signal (β) was positive and the p-value significance (Sig = 0.000) was less than the significant level (0.05), which confirms the validity of the third hypothesis. These findings are consistent with [34], which found that big data analytics improves financial performance. This relation is shown by the following model:

$$FP\ i,t\ =\ .113\ + \beta 1\ .064\ + \beta 2\ .011\ - \beta 3\ .013\ - \beta 4\ .001\ + \beta 5\ .021\ + \beta 6\ .004\ + \beta 7\ .014\ +\ \varepsilon\ i,t$$

The following table summarizes the results of testing the study hypothesis:

Table 10: Study Hypotheses Test Results

H.	Variables	Expected relation	Actual relation	Test
H1	Determinants of big data analytics	+	+	**Valid**
H2	Big Data Analytics and Efficient Investment Decision	+	+	**Valid**
H3	Big Data Analytics and Financial Performance	+	+	**Valid**

5. Conclusion:

Considering the information revolution and the huge volume of information disclosed by companies recently, whether historically or future information in financial reports or through periodicals or electronic disclosure via official websites, the role of information has emerged in directing capital and influencing investors' decisions, whether positively or negatively. As a result, the information officially disclosed by corporations is considered one of the factors that directly affect the efficiency of investment decisions. Our study provided new evidence from Saudi Arabia about the determinants of big data analytics, in addition to the impact of BDA on investment efficiency and financial performance. Finally, we argued that Firm Size, Cash Flows, Growth Opportunities, and Dividend Policy have a positive significant impact on the adoption of big data analytics. Where Leverage and Working Capital have a positive significant impact on the adoption of big data analytics. Moreover, there is a positive impact of the adoption of big data analytics on investment efficiency. And there is a positive impact of the adoption of big data analytics on the financial performance.

6. Acknowledgement:

The authors extend their appreciation to Prince Sattam bin Abdulaziz University for funding this research work through project number (PSAU/2022/02/23389)

Conflict of interest

The authors declare that there is no conflict regarding the publication of this paper.

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