

Factors Affecting the Adoption and Use of Big Data and The Moderating Effect of Information Quality

Mohammed Bassam Nassoura^{ID}, Nabil Abudarwish Zarqa^{ID}, Mohammad Musa Al-Momani^{ID},
Bilal Alnassar^{ID}, AbdelRahman Ismail^{ID}, Ahmad Awadallah^{ID}
Zarqa University, Department of Business Information Technology, Zarqa, Jordan

Abstract—This research aims to explore the impact of various factors on the adoption and application of big data in small and medium-sized enterprises (SMEs) operating in the service sector in the Hashemite Kingdom of Jordan. The research employs a quantitative analytical methodology, grounded in the theory of technology, organization, and environment. The research aims, firstly, to assess the impact of various technical, organizational, and environmental factors on the adoption and use of big data, and secondly, to explore the moderating role of information quality. The research population comprises Jordanian SMEs operating in the service sector. This study was conducted with the participation of the company's managers and executives, and included a sample of 271 individuals. A questionnaire was used to collect the required data, which was then analyzed using the SmartPLS structural equation modeling technique. According to the study's findings, several technical, organizational, and environmental factors positively influence big data implementation processes. Furthermore, the study revealed a significant moderating effect of information quality. In other words, the study concluded that the successful adoption of big data by SMEs is possible if there is integration between the various dimensions of the TOE framework and information quality, particularly in the areas of management and organization. This will contribute to raising the efficiency of the Jordanian services sector and enhancing its competitiveness.

Keywords—Big data; information quality and theory of technology; organization; and environment

I. INTRODUCTION

Companies based in the Hashemite Kingdom of Jordan, especially those working in the services industry and categorized as SMEs, are witnessing unprecedented levels of digitization as a consequence of technological developments in information and communication technologies [1]. This phenomenon has paved the way for the emergence of Big Data Analytics, which has become one of the most vital modern management techniques utilized by firms as a strategic means of analyzing enormous volumes of data, deriving useful insights that aid decision-making processes, improving organizational performance, and increasing competitive advantage in a continuously evolving business environment [2]. In such circumstances, the success of companies does not revolve around simply having traditional resources but revolves around the capability to use the data for generating value.

Despite its increasing relevance, there are numerous disparities concerning the adoption and usage of Big Data technologies.

SMEs face various obstacles related to technological infrastructures, organizational aspects, and environmental factors [3]. This means that the adoption and usage of Big Data are affected by more than purely technological considerations. These factors include both internal organizational features and external environmental issues influencing the company's readiness to introduce innovative solutions.

In order to understand the dynamics of adoption of new technologies from a scientific perspective, this study applies the TOE Framework, which is one of the central theories regarding the introduction of innovations in organizations. According to this approach, any technological solution's adoption depends on three key elements, namely, the technological context, the organizational context, and the environmental context [4]. The technological context concerns the technological infrastructure of the organization and its ability to accommodate innovations like Big Data applications. The organizational context includes the level of support by the management, skills of employees in terms of their proficiency in digital technologies, and organizational culture facilitating change and innovation. Finally, the environmental context refers to the external environment and its influence on technology adoption, which includes market pressure, governmental support of digitalization, and technology itself [5].

In this regard, a list of the major factors influencing the implementation and usage of Big Data by SMEs has been chosen. They include technological factors such as the quality of the technological infrastructure and system compatibility, organizational factors like the support from senior management and digital literacy of the employees, and environmental factors like competition and the support provided by the government. Together, these factors help identify the readiness level of organizations when it comes to using Big Data technologies.

However, the application of big data alone does not guarantee success; in fact, the success of this technique relies in part on the quality of data available [6]. Data quality is key to the success of results and the effectiveness needed for the analysis. Information quality includes the correctness, completeness, timeliness, and consistency of the data, along with direct and efficient availability for leveraging different types of data in the organization. Good information quality can also be utilized to strengthen or reduce the effect of factors that influence adoption and their negative effects. This means that good data ensures greater effectiveness of such factors.

Thus, the problem of the study can be seen as a noticeable difference in the level of application of big data technology in small and medium-sized companies in Jordan, even though there is a presence of some of the technological components [7]. Such differences have resulted as a consequence of the difference in the extent to which these components have been affected by different technological, organizational, and environmental factors, apart from information quality. In light of that, the main research question is: To what extent do technical, organizational, and environmental factors affect the formation of critical data in small and medium-sized organizations in Jordan, and what role does information quality play as a moderator variable in these relationships? The objective of this study is to provide several areas for expansion for studying the effect of technical, organizational, and environmental factors on the generation of critical data, the measurement of information quality in such situations, and the moderating role of information quality in ratios of factors affecting big data.

As indicated above, it is now possible to develop a practical framework to analyze the impact of various considerations in selecting the TOE model when using big data. Information quality is noted to be one of the crucial considerations when implementing the use of big data as a measure to increase capacity to participate effectively in Jordanian workplaces.

II. LITERATURE REVIEW

A. Technological Factors and Big Data

According to recent scholarly research in digital transformation, it is clear that the adoption of big data by digital enterprises is dependent on technological aspects [4]. The readiness of the organization concerning technology, which refers to technological advancement within the company, its strong technological foundation, good information systems, and high-definition data storage capacities, has a great impact on managing complex volumes of data. The better developed the organization is technologically, the more able it is to incorporate analytics approaches.

On the contrary, the lack of correct information or problems with incompatible networks were found to constitute an important barrier to the development of big data technologies. As a result, there are problems in combining data from different sources, flaws in the technical analysis process, as well as unreliability of the outcomes obtained during the extraction process [8]. Hence, companies that are poorly prepared for technology tend to face certain barriers associated with the high cost and complex process of adopting such innovations. In turn, one may assume that technological aspects do not only cover issues related to the scope of technology adaptation, but also its real involvement of factories in the work of the company, which is a very important aspect of successful innovation of big data technologies by SMEs.

H1: Technological factors have significant positive effects on big data in SMEs.

B. Organizational Factors and Big Data

In the area of information systems and digital transformation, literature shows that these aspects are among the main determinants for the success of implementing different

technologies in organizations [4]. This relates to the modern fundamentals of organizational capacity development, in particular human capital, which includes a set of people who are directly engaged in gathering and using data.

It should be noted that support from the modern manager is also an essential aspect, as it provides financial and digital resources, directs employees to digitalization processes, and motivates them to use the add-ons [9]. Finally, digital skills and human capabilities in the organization come from the ability of the employees to comprehend data technologies and use their output for innovation purposes. Otherwise, poor skills and lack of training may become a hindrance to adoption.

Furthermore, the core principles of these comprehensive changes revolve around reducing the number of individuals and fostering a different mindset in dealing with information. Thus, by combining these overarching factors, a unified internal community of individuals is created, driving diverse innovations in the field of data.

H2: Organizational factors have significant positive effects on big data in SMEs.

C. Environmental Factors and Big Data

Research on technology innovation and information systems shows that the use of big data in meeting key organizational objectives is one of the gaps that are evident in the literature. In accordance with the TOE framework, technology adoption does not occur in an environment vacuum but is shaped by the environment's changing presence and possibilities provided by the external entity [10].

Market competition, however, does not play a major role, as several competitors distinguish themselves through critical utilization of data analytics to handle customers, improve efficiency, and speed. The necessity exists in using data collaborations as well as data analytics technologies for better positioning in the market [11].

The role played by government support and national digital transformation is vital in order to act as important catalysts, together with modern digitalization efforts and infrastructure. Another major issue is related to the organizational environment, which cannot adapt to these changes and the new competitive environment. Consequently, it appears that the interaction between these various environmental factors adds to pressures and opportunities for small businesses to use different types of data technologies.

H3: Environmental factors have significant positive effects on big data in SMEs.

D. The Moderating Effect of Information Quality

Emerging studies have shown that information quality not only acts as an important determinant of the success of the application of big data [12], but it is also a key moderator in determining the effect that adoption factors (technological, organizational, and environmental factors) have on adoption and the utilization of big data technology. High information quality in terms of accuracy, completeness, timeliness, and consistency increases the potential of organizations to successfully capitalize on these adoption factors.

From a technological point of view, high information quality increases the extent to which companies make use of their existing technological infrastructures and information systems, hence increasing the influence of technological factors on adoption [13]. From an organizational perspective, high-quality information assists managers in making informed decisions while at the same time ensuring that employees are efficient in using big data technologies, hence increasing the influence of organizational factors on adoption [14,15]. When it comes to the environment, high-quality information will enable firms to adapt to changing environments and compete better in the market, thus speeding up technology adoption and implementation

[15,16,17]. In this respect, high information quality becomes a moderating variable, since its presence makes the relationship between the different dimensions of the TOE framework and big data adoption much more evident and effective.

H4: Information quality moderately affects the relationship between technological factors and big data.

H5: Information quality moderately affects the relationship between Organizational factors and big data.

H6: Information quality moderately affects the relationship between Environmental factors and big data.

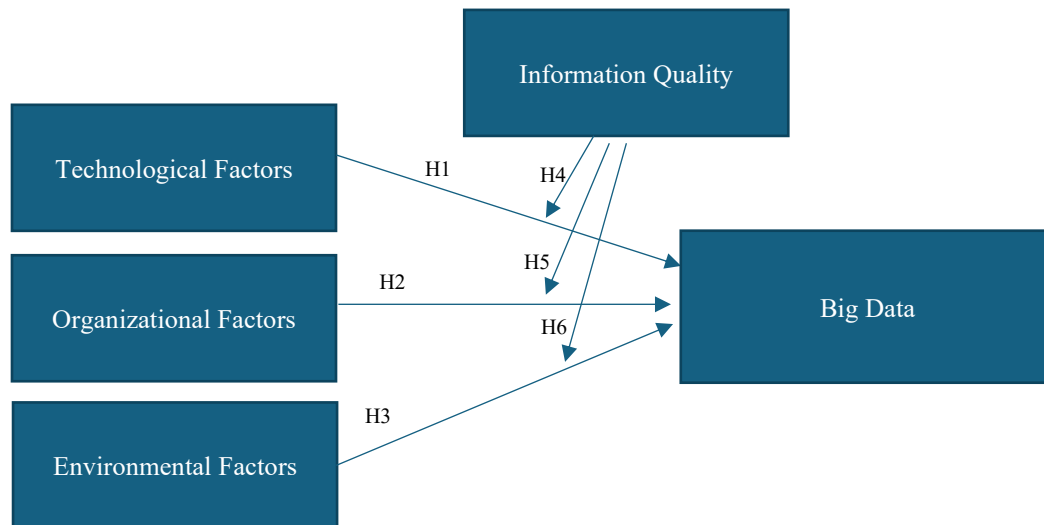


Fig. 1. Conceptual framework.

III. METHODOLOGY

A. Research Design

The current research will make use of analytical models that involve quantitative analysis in the study of relationships between the research variables using the TOE Framework (See Fig. 1). Quantitative methodology is suitable for this study due to its ability to help analyze the causality of the relationship between technical, organizational, and environmental variables and the creation of big data, in addition to the effect of information quality as a moderator. In addition, the study will also use a descriptive correlational design, which will assist in understanding the nature of the relationship without changing the dynamics of the variables.

B. Study Population

The population selected for this research comprises small and medium-sized enterprises that are working in the service sector within the Hashemite Kingdom of Jordan. This is because of the significant role played by this specific sector in the nation's economy, along with growing participation in leadership roles [18]. The companies vary regarding big data utilization.

C. Sampling Method and Techniques

This study targeted IT managers and executives in small and medium-sized companies due to their direct role in organizational technology decision-making and their knowledge

and experience, which enable them to provide reliable assessments of big data adoption and utilization. Given the difficulty of obtaining a comprehensive sample of all qualified managers in these categories, as well as the managerial nature of the participants and the challenges of reaching them, a convenience sampling approach was adopted as a practical method for accessing participants with relevant organizational knowledge and experience. To ensure data quality and participant suitability for the research objectives, specific inclusion criteria were applied, limiting participation to individuals with sufficient knowledge of the data practices and technologies used in their organizations. After excluding incomplete or ineligible responses, 271 responses were valid for analysis. While the convenience sampling approach may reduce non-response bias and facilitate access to participants with relevant information, its non-probability nature may lead to selection bias and limit the statistical generalizability of the results to the entire study population. Therefore, this limitation was explicitly addressed in the interpretation of the results, emphasizing that the sample was specifically targeted at the most suitable participants to provide reliable and relevant information. It is recommended that future studies employ probabilistic sampling methods, such as stratified random sampling, and expand the sample geographically and organizationally to enhance the generalizability and validity of the findings in diverse contexts.

D. Measurement Variables

The research employed criteria that were based on prior research carried out in the form of peer-reviewed scientific articles but modified to fit the findings of this particular study [19]. The technological criterion was assessed with the help of the integration of artificial neural networks in accordance with literature on technology adoption based on emerging technology theory [20]. Components of the technological criterion were supported by the involvement of senior management and digital competence, which could be attributed to literature on information system adoption [21]. Although negative aspects such as government pressures that have been identified in prior studies [22] were not taken into account, their contribution was disregarded in this study.

In addition, another novel method to arrange information concerning biodiversity data was also proposed based on the results from internal research and application of this approach using big data analytics [23, 24, 25]. Lastly, information quality was evaluated based on four major components: accuracy, completeness, events, and leg count that are related to the success model of information presence systems [26].

E. Data Collection Process

The data collection process was carried out by distributing questionnaires to company executives (as shown below), via electronic and in-person methods, to make sure that there was the maximum possible coverage and profit. The aim of the study was provided to the participants, together with a document guaranteeing the confidentiality of the information, which is relevant only to scientific purposes.

Another part of the process included conducting a pilot study with 30 people from the study sample to check whether the questionnaire questions were clear and understandable. The findings from this step ensured the reliability of the questions and confirmed the availability of the final data.

F. Data Analysis Approach

Analysis was done through the SEM approach using SmartPLS because of the capability of SmartPLS to analyze complicated correlations among independent, mediating, and dependent variables. It involved two phases – the Measurement Phase that integrated the concepts of validity and reliability, and the Structural Phase that matched the hypotheses and relations among the co-opting variables.

IV. RESULT

A. Participant Data

The demographic profile of the study participants was examined based on gender, age, educational qualifications, years of experience, occupational role, and company size. The findings revealed that most participants were in the age group of 30-40 years, while most of them had managerial or technical roles related to the implementation and functioning of information systems and data analysis in their organizations.

It was found that SMEs are increasingly making use of information technology in their processes, indicating the rising trend of big data applications among organizations in the

services industry in Jordan. Information on the demographics of study participants is provided in Table I.

TABLE I. PARTICIPANT DEMOGRAPHIC PROFILE

Variable	Category	Frequency	Percentage
Gender	Male	168	62%
	Female	103	38%
Age	Under 30 years	57	21%
	30-40 years	124	45.8%
	41-50 years	63	23.2%
	Over 50 years	27	10%
Educational Qualifications	Diploma	39	14.4%
	Bachelor's	171	63.1%
	Postgraduate	61	22.5%
Years Of Experience	Less than 5 years	68	25.1%
	5-10 years	119	43.9%
	Over 10 years	84	31%
Occupational Role	Business Size Small	157	57.9%
	Medium	114	42.1%
Occupational Role	managers	179	66.1%
	executives	92	33.9%

B. Statistical Methods

To accomplish the purposes of the research and test the proposed hypotheses, partial least squares structural equation modeling (PLS-SEM) was applied. It is a suitable statistical tool in cases where interpretative research is conducted, and models are quite complicated since they include modified multidimensional variables, as well as when normality is not required.

The Kolmogorov-Smirnov test was employed to verify whether the data are normally distributed. According to the obtained results, the statistical significance of all variables is lower than 0.05; thus, the data are not normally distributed. In this case, the use of PLS-SEM is justified.

Reliability, convergent validity, and discriminant validity were performed on the measurement model by calculating external loadings, composite reliability (CR), and average extracted variance (AVE). Following the validation of the measurement model, structural model testing was conducted to examine the relationships among the independent and dependent variables. Moreover, the moderating effect of information quality in the influence factors-big data analytics adoption relationship was investigated (see Table II).

Results indicated that all values of workload were greater than 0.70, signifying a strong correlation between the elements and their underlying change; hence, there was no need for elimination of any element in the model.

Anticipatory correlation to onset ratio (HTMT) was chosen since it proved that the evaluators actually collaborated (see Table III).

TABLE II. RESULTS OF RELIABILITY AND CONVERGENCE

Construct	Items (22)	Loading Factors	Cronbach's Alpha	Composite Reliability	AVE
Technological Factors	4	(0.831-0.874)	0.912	0.928	0.721
Organizational Factors	4	(0.817-0.866)	0.903	0.921	0.699
Environmental Factors	4	(0.801-0.842)	0.887	0.914	0.682
Information Quality	5	(0.851-0.884)	0.918	0.935	0.739
Big Data.	5	(0.857-0.895)	0.926	0.942	0.762

TABLE III. DISCRIMINANT VALIDITY

	Technological Factors	Organizational Factors	Environmental Factors	Information Quality	Big Data.
Technological Factors	-				
Organizational Factors	0.744	-			
Environmental Factors	0.701	0.287	-		
Information Quality	0.693	0.715	0.672	-	
Big Data.	0.803	0.781	0.744	0.819	-

The findings show that independent variables account for 67.1% of the variance in big data adoption, a considerable percentage that indicates the model's explanatory power (see Table IV).

TABLE IV. R SQUARE

	R ²	Q ²
Big Data	0.671	0.432

C. Hypotheses Test

These hypotheses have been tested through structural modeling via PLS-SEM based on the analysis of path coefficients and t- and p-values.

According to the findings, there is a significant influence of technological, organizational, and environmental determinants on the implementation and usage of big data analytics within Jordanian SMEs. Additionally, it was found that the quality of information has a significant effect as a moderator on the impact of the above-mentioned variables on the implementation of big data. This finding implies that the more accurate the information in an organization, the better it will be able to utilize the power of big data and make better decisions (see Table V).

TABLE V. HYPOTHESES TEST

	β	t-value	p-value	Support
Technological Factors → Big Data	0.339	5.915	0.000	Supported
Organizational Factors → Big Data	0.292	4.883	0.000	Supported
Environmental Factors→ Big Data	0.248	4.1964	0.000	Supported
Technological Factors × Information Quality → Big Data	0.183	3.527	0.001	Supported
Organizational factors × Information Quality → Big Data	0.169	3.119	0.002	Supported
Environmental factors × Information Quality → Big Data	0.142	2.875	0.004	Supported

V. DISCUSSION

This study sought to investigate the influence of the variables that affect the adoption and usage of big data analytics technology by Jordanian small and medium-sized businesses within the service industry through the application of the Technology-Organization-Environment (TOE) approach. This study also attempted to identify the effect of information quality as a moderator in the relationship between technological, organizational, and environmental variables and the degree of adoption of big data analytics technology.

The results of this research prove the presence of a positive effect of technological aspects on big data technology adoption. It means that the presence of technological infrastructure, modern digital systems, and technical skills inside the company are crucial for the promotion of big data use inside the organization. This statement is true due to the fact that SMEs, which possess information systems and communication networks, can efficiently collect, process, and implement data into their activities. This statement shows a tendency for companies in Jordan to invest in modern technologies and improve their processes through digital transformation. This statement is confirmed by a number of previous investigations proving the significance of technological preparedness in promoting big data adoption. In addition, there is a positive influence of organizational factors on big data adoption, as the support of senior management and skilled human resources help in adopting big data technology inside the company.

This result demonstrates that firms that train and assist their workers and have a well-articulated vision of digitalization would be better able to adopt and apply the principles of advanced analytics techniques to increase organizational efficiency. It shows the crucial importance of senior management in creating a flexible organization that motivates its workers to make decisions based on data analysis.

Additionally, the findings reveal that environmental forces have a positive impact on the adoption of big data. From this perspective, one can observe that increased market competition, pressure from customers, and quick changes in the business

environment make organizations adopt big data technologies in order to improve the quality of services and become more responsive to market needs. In turn, the mentioned findings reveal that Jordanian organizations are starting to recognize the significance of big data for their competitive advantage and adaptability to the external environment. One of the main explanations for this trend lies in the fact that today's business environment requires prompt and effective decision-making based on data analysis.

Among the significant results of the present study, it is necessary to emphasize the moderating effect of information quality on the connection between different factors of technological, organizational, and environmental nature and the adoption of big data technology. As one can see from the above findings, the presence of high-quality information improves the impact of the other mentioned factors and leads to more effective implementation of the big data strategy by providing the basis for obtaining positive outcomes from the use of digital tools. In spite of the high level of technological and organizational preparedness, information quality remains an integral component of the process in question since poor quality will not allow an organization to take full advantage of big data opportunities.

VI. THEORETICAL AND PRACTICAL CONTRIBUTIONS

A. Theoretical Contributions

This research study provides a theoretical contribution in regard to adopting digital technologies and the use of big data analytics in organizations. The technology, organization, environment (TOE) framework is utilized in this study as a theoretical framework used to explain the determinants that affect the usage of big data analytics in SMEs in the Jordanian service industry. The study indicates that the TOE framework can be considered a suitable explanatory model that can be used even outside technological environments.

Additionally, the research advances the existing body of literature by introducing information quality as a moderating variable into the model. This improves the theoretical understanding of the connection between technology, organization, and environment variables and big data analytics adoption. The importance of this advancement lies in the fact that the success of adopting new technologies requires more than just having all required factors. Namely, the quality of information held by the organization plays a key role in the process. Hence, the traditional theory receives its enrichment from a different perspective. Furthermore, the research suggests an integrated model that includes three variables within the TOE framework and a moderating variable. The research contributes to the existing literature in terms of providing the basis for further examination of big data analytics implementation at SMEs, especially in developing countries such as Jordan. The research closes the existing research gap concerning the lack of literature on the moderating role of information quality in big data implementation.

B. Practical Contributions

This research provides some significant practical contributions that can be useful for managers in SMEs operating in Jordan. First, it becomes clear that it is necessary to focus on

improving the technological infrastructure in the organization since it is one of the key prerequisites for big data adoption. Therefore, managers should ensure that they make an investment in modern digital technologies and develop their own analytical skills.

The other contribution made by this study involves highlighting organizational aspects related to the adoption of technologies. Managers need to actively contribute to organizational change and create favorable conditions for digital adoption by offering training programs and encouraging innovation and evidence-based decision-making.

In addition, the role of the environment cannot be overlooked. SMEs face stiff competition and growing customer demands; thus, in order to survive, they have no choice but to implement big data analytics solutions so that they can increase their service quality and become more competitive in the market.

When it comes to the practical implications of the study, it should be noted that data quality is essential to implementing big data analytics successfully. This means that firms should be concerned with ensuring data quality because any issues with it can result in flawed decision-making. Additionally, the study provides some practical advice for the Jordanian government regarding the implementation of digital transformation within the country's SMEs. In particular, the government needs to create the necessary digital infrastructure, invest in big data, and implement special training programs.

Lastly, the results of this research contribute to the identification of the important factors that can determine the successful implementation of big data analytics and allow organizations to formulate better strategies for enhancing their competitiveness.

VII. CONCLUSION

This study aimed to analyze the factors influencing the adoption of big data analytics among small and medium-sized enterprises (SMEs) in the Jordanian services sector, using the Technology-Organization-Environment (TOE) framework, with a focus on the moderating role of information quality. The results showed that technological, organizational, and environmental factors all contribute positively to the adoption of big data analytics, underscoring the importance of technological readiness, senior management support, human capital, and environmental pressures in promoting digital transformation. The results also demonstrated that information quality strengthens the relationship between technological factors and big data analytics adoption, indicating that technological readiness is most effective when accurate, reliable, relevant, and timely information is available. Thus, the study contributes to broadening the application of the TOE framework by highlighting the importance of information quality as a key factor in achieving more effective big data adoption. In practical terms, the results suggest that SMEs should adopt an integrated approach that combines technological investment, organizational and human capacity building, and improved information quality. However, the study's reliance on a cross-sectional design and convenience sampling limits the generalizability of the results, allowing future studies the

opportunity to test the model using probability sampling, longitudinal designs, and in different cross-sections and environments.

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