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The adoption of big data analytics in Jordanian SMEs: An extended technology organization environment framework with diffusion of innovation and perceived usefulness

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A B S T R A C T

While many small and medium enterprises (SMEs)recognize the benefits of Big Data Analytics (BDA) for digital transformation, they face challenges in implementing this technology, highlighting the need for more research on its adoption by SMEs. The objective of this study is to amalgamate the Technology Organization Environment (TOE) framework with the Diffusion of Innovation (DOI) theory, aiming to dissect the factors that sway BDA adoption in Jordanian SMEs. Additionally, the study delves into how perceived usefulness impacts this adoption process. Utilizing structural equation modeling, the study examined data from 388 managers in Jordan. The study validates all its hypotheses, revealing that variables like relative advantage, compatibility, complexity, top management support, competitive pressure, and security influence perceived usefulness, which subsequently has a positive impact on BDA adoption. This research presents a range of theoretical and practical insights.

1. Introduction

Recent advancements in technology have significantly reshaped multiple sectors, enhancing both commercial operations and daily life experiences. This transformation is evident as an increasing number of businesses adopt technological innovations to improve efficiency and drive growth (Al-Momani & Ramayah, 2023b, 2023c; Alzyoud et al., 2024). In terms of limits and physical temporal these signs of progress are crucial for surpassing the limitations of the study, and demonstrating the extensive effects (Abu-Shanab, Ababneh, et al., 2012; Abu-Shanab, Al-Momani, et al., 2012). A conspicuous example of this technical progress is in the emergence of Industry 4.0, which is based on various important technologies such as the Industrial Internet of Things (IIoT), cybersecurity, and augmented reality (Rubmann et al., 2015). These technologies collectively advance the transmission of information between systems, which allows for higher control over operations and increases flexibility in changing situations (Moeuf et al., 2018). An emerging and rapidly advancing area of research is the incorporation of Industry 4.0 into SMEs which highlights the wide importance of these innovations in technology(Shqair & Altarazi, 2022).

In recent years, an increasing range of companies has analyzed the advantages of Big Data (BD) in facilitating their digital transformation and gaining expedited insights from the data analysis (Al-Azzam et al., 2023; Al-Sai et al., 2019). The significance of BD increase is illustrated by its extensive discussion in numerous areas worldwide (Ahmad et al., 2019; Al-Azzam

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et al., 2023). The deep focus on BD highlights its importance as a significant resource for both commercial and government organizations (Al-Sai et al., 2019). According to Manyika et al. (2011) BD refers to the datasets that surpass the processing capabilities of traditional database software, while on the other hand, BDA refers to contemporary technologies and advanced frameworks to get value economically from a broad amount of diverse data with facilitating rapid data collection, exploration and analysis (Gandomi & Haider, 2015), which it includes two aspects; such as data and analysis (Maheshwari et al., 2021). The data aspect contains the provision of information and technology assistance which requires analytical progress, while the analysis aspect provides firms with crucial strategic insights. These observations can have a pivotal impact on decision making when it comes to efficiently employed (Juma & Kilani, 2022).

A nation such Jordan with an upper-middle-income status, depends extremely on SMEs as the prime mover of its economy. Based on Abu-Mater et al. (2021) approximately in 2021, 95% of Jordan's business sector was formulated as SMEs. This statistic demonstrates the highly important effect of SMEs over Jordan's economic environment. Their dominant influence suggests that SMEs are fundamental to the economy, they embrace a huge range of sectors and services. Along with, around 95% of all officially registered companies are constitute by SMEs, which makes up over 50% of gross domestic product (GDP), with employing an estimated of 60% of the total workforce (Shqair & Altarazi, 2022).Furthermore, SMEs' contribution of over 50% of Jordan's GDP demonstrates that SMEs, despite operating with fewer resources than larger companies, are still able to produce a significant portion of the nation's economic outcome.

Jordan's ranking in the Network Readiness Index (2022) underscores its strong focus on technological advancement and future growth despite economic challenges (Al-Momani & Ramayah, 2023a). Ranked 41st out of 131 countries globally and fifth among Arab nations (see Fig. 1), placing Jordan alongside nations like the United Arab Emirates (UAE), Qatar, Saudi Arabia (SA), and Bahrain. Additionally, Jordan's position in the adoption of emerging technologies is noteworthy, both globally and among Arab nations (see Fig. 2). Ranking 59th globally, this demonstrates Jordan's robust capability and strategy to integrate emerging technologies across its economy, society, and infrastructure.

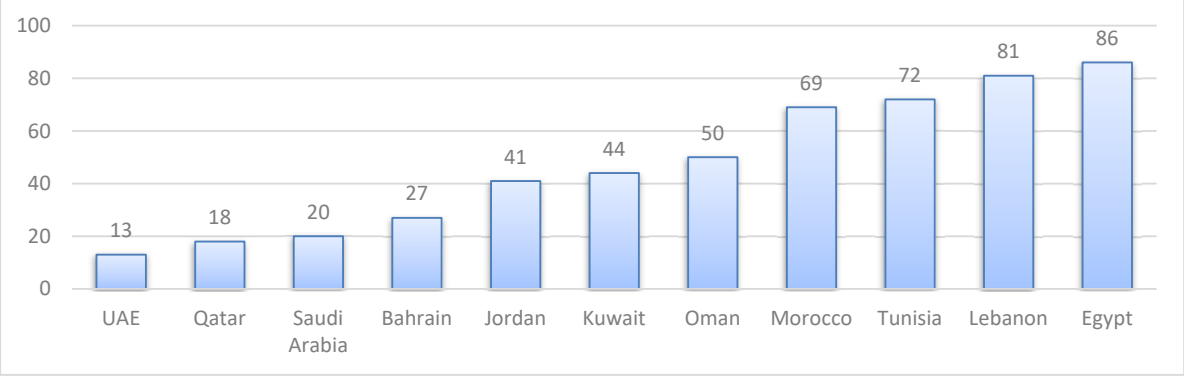

Fig. 1. Ranking of Arab countries in future technologies (Network Readiness Index, 2022).

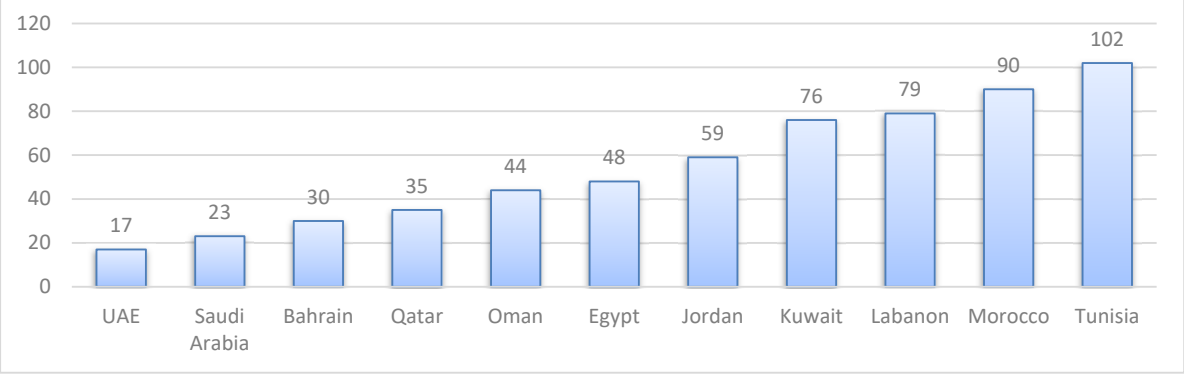

Fig. 2. Ranking of Arab countries in adoption of emerging technologies (Network Readiness Index, 2022).

1.1. Research Gap

Since its introduction in indexed journals around 2012, the field of BDA has increasingly captured scholarly attention. Fig. 3 shows that the Scopus database contains 1,688 articles on this topic. Furthermore, a bibliometric analysis conducted using VOSviewer reveals the most frequently occurring author keywords in these articles. The terms include "big data analytics" (f

= 1,335), “technology adoption” (f = 18), “TOE” (f = 6), and “SMEs” (f = 10), as detailed in Fig. 4. Accordingly, several research gaps have been examined. Firstly, Coleman et al. (2016) and Liu et al. (2020), have underscored the vital role of BDA in SMEs and its importance for national economic growth. Moreover, SMEs face hardness when it comes to the practical implementation of this cutting-edge innovation (Liu et al., 2020; Maroufkhani et al., 2020, 2023; Mikalef et al., 2020).Besides, although multiple studies have tested the implementation of BDA in SMEs (Liu et al., 2020; Lutfi et al., 2022; Mangla et al., 2021; Maroufkhani et al., 2020; Saleem et al., 2020), but further study is required to explore the effect of BDAin SMEs(Liu et al., 2020; Maroufkhani et al., 2023; Mikalef et al., 2020; Youssef et al., 2022).

Moreover, adopting BDA in the context of SMEs, an important gap is being observed in this research which assimilate the framework of technology-organization-environment (TOE), which is established by Tornatzky and Fleischer (1990)with the diffusion of innovation (DOI) theory (Rogers, 2003). TOE framework and DOI theory in this study aims to explore the factors that influence the adoption of BDA in SMEs specifically in Jordan.

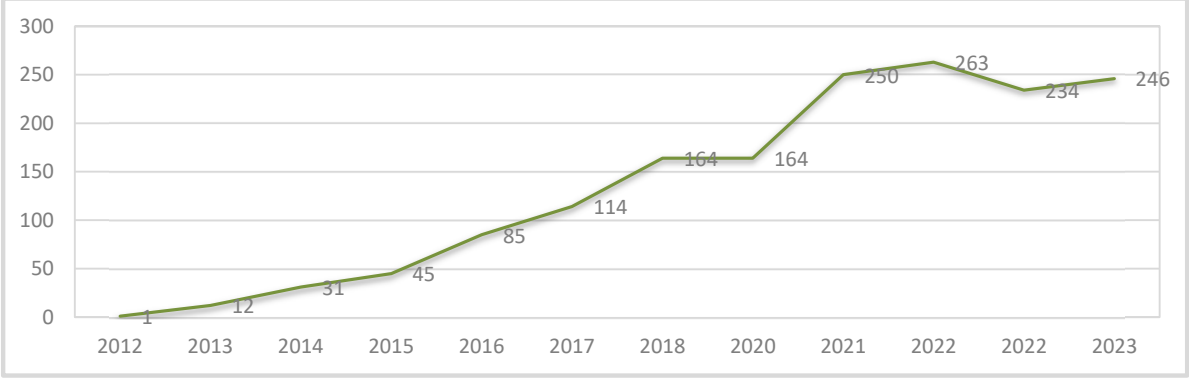

Fig. 3. Number of articles published from 2012 to December2023 (Scopus database).

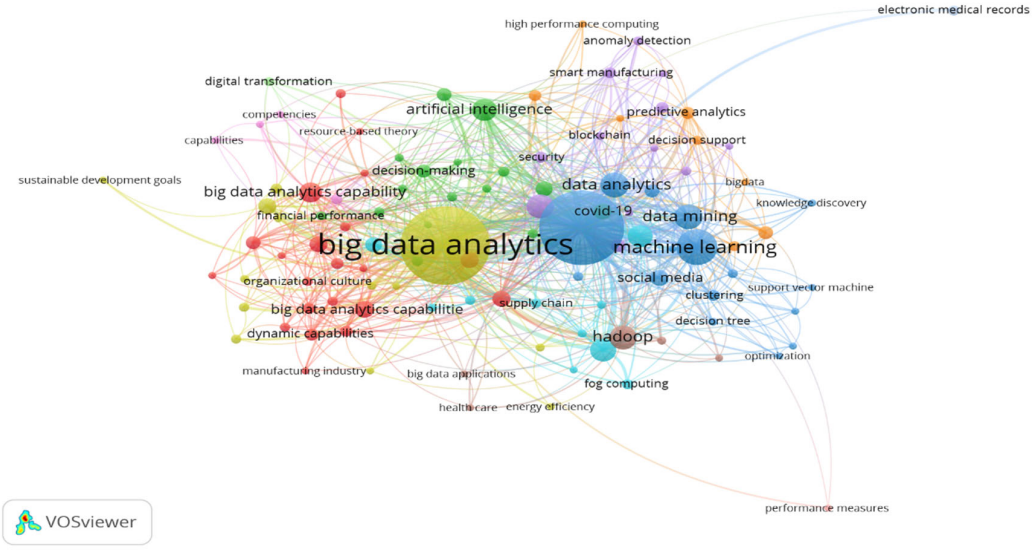

Fig. 4. The most used keywords.

2. Theoretical Background and Hypotheses

The importance of the TOE and DOI theories is highlighted by Oliveira et al. (2019) and Lutfi et al. (2022)to understand the progress in which SMEs embrace technology. Investigating how the attributes of technology influence its adoption within companies is considered as DOI theory which is suggested by Sun et al. (2020).On the other hand, Awa et al. (2017) suggest assimilating the technology acceptance model (TAM) into the TOE framework. Consequently, this process incorporates the concept of perceived usefulness into the TOE framework because of its crucial influence on the adoption of recent technologies (Al-Abbadi et al., 2022; Al-Momani, 2023a, 2023b; Al-Momani & Ramayah, 2023a). Furthermore, as stated in Fig. 5, the technological factors of the suggested model were earned from the DOI theory.

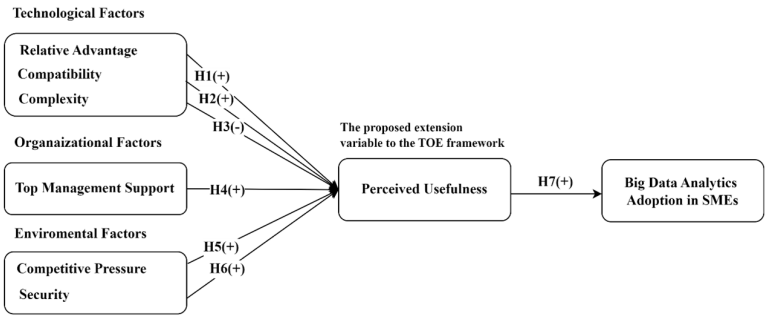

Fig. 5. Conceptual model of study.

Compared to its processor, relative advantage refers to the perceived superiority of an invention (Rogers, 2003). When the perceived advantage is higher than the innovation it leads to being accepted quickly (Rogers, 2010). Within organizations this is a special evident in IT adoption, where the superiority over existing technologies plays a pivotal role (Alaskar et al., 2021). Lots of studies have confirmed the effect of relative advantage on adoption (Abu-Taieh et al., 2022; Al-Quran et al., 2023; George et al., 2023; Ramadan & Eleyan, 2021; Wang et al., 2022). Consequently, the following hypothesis is proposed:

H_1: *Relative advantage positively influences perceived usefulness.*

Compatibility measures how well an innovation agrees with the values and prior experiences of users based on Rogers (2003). Moreover, those organizations favor technologies that align with their existing culture and values (Alsetoohy et al., 2019). Furthermore, it is crucial for each organizational needs and its IT infrastructure to be in sync with BDA (Alathamneh & Al-Hawary, 2023; Youssef et al., 2022). Various studies support the positive effect of compatibility on perceived usefulness (Abu-Taieh et al., 2022; Puiu et al., 2023; Truong, 2022). However, Yoon and Lim (2020)observed no significant impact of compatibility on perceived usefulness. Consequently, the subsequent hypothesis was proposed:

H_2: *Compatibility positively influences perceived usefulness.*

Rogers (2003)highlighted that the adoption of new technology can be unsuccessful if it is perceived as too complex and challenging. Kapoor et al. (2014) define complexity as the level of difficulty in understanding and implementing an invention. Oliveira et al. (2014)found that the probability of technology adoption is higher when its incorporation into corporate operations is uncomplicated. Alsetoohy et al. (2019)emphasized that the complex nature of technology poses a significant barrier to its adoption. Lutfi et al. (2022) argue that for successful adoption, it is vital for employees to easily understand the innovation, as complex technologies can add uncertainty and intricacy. A negative influence of complexity on perceived usefulness was observed by Mas'adeh (2016), Abu-Taieh et al. (2022) and Yoon and Lim (2020) found that there is no relationship between them. Thus, the hypothesis formed correspondingly:

H_3: *Complexity negatively influences perceived usefulness*.

For making a suitable environment and providing accurate resources for the new technology adoption the top management support is important (Eleimat et al., 2023; Verma & Chaurasia, 2019). Understanding the organizational benefits of the active participation of senior managers is critical in encouraging a positive setting for innovation and technology uptake (Zach et al., 2020). In SMEs it is essential to have the role of decision-maker and typically at the top-management level with their commitment and backing being a key to successful innovation implementation (Jahanshahi & Brem, 2017). The useful influence of top management support on perceived utility has been validated by Mas'adeh (2016), Ramadan and Eleyan (2021), and Abu-Taieh et al. (2022) which is leading to the proposal of the following hypothesis:

H_4: *Top management support positively influences perceived usefulness.*

With competing pressure as the external forces that drive organizations to adopt BDA, which was influenced by customers, suppliers, and competitors (Chen et al., 2015). This forms how firms respond to modern technology. In SMEs increasing competition correlates with higher chances of successful a new technology adoption (Maroufkhani et al., 2020). Wang et al. (2022) also establish that competitive pressure increased the perceived utility of such technologies. In addition, this study proposes the upcoming hypothesis:

H_5: *Competitive pressure positively influences perceived usefulness.*

Regarding website measures by Shah et al. (2014) security is assessed by users, and it also considerably influences their agreement with modern technologies(Al-Momani & Ramayah, 2023a), particularly where the data innovations need assured security(Asiaei & Rahim, 2019). When considering data service adoption, business managers categorize security(Asiaei &

Rahim, 2019). Another scholar identified security's effect on perceived usefulness Masadeh et al. (2023) which contradicts the results by Al-Momaniand Ramayah (2023a). This study proposes the security influences, and the perceived usefulness and presents the following hypothesis:

H_6: *Security positively influences perceived usefulness*.

TAM proposes that perceived usefulness (PU) is a significant factor affecting the acceptance of an information system(Davis, 1989). Davis defines PU as an individual's belief that using a specific system would enhance their performance (Davis, 1989). The value of PU is derived from the perspective that the relevance of technological advancement is tied to its utility (Eresia-Eke et al., 2023; Shamaileh et al., 2023). Eresia-Eke et al. (2023)corroborated the beneficial impact of PU on BD adoption. Additionally, research by Ramadan and Eleyan (2021) and Truong (2022)supported the notion that PU fosters technology adoption. Based on these insights, the current study puts forth a hypothesis:

H_7: *Perceived usefulness positively influences BDA adoption.*

3. Methodology

3.1 Design

As part of this research approach, the positivist perspective is adopted with the BDA in Jordanian small and medium enterprises. Hence, this positivist approach enables the methodical collecting and analysis of quantitative data to grasp the aspects that lead to the adoption, primarily in light of the study's emphasis on Jordanian SMEs' adoption of (BDA) (Amiruddin et al., 2023; Smadi et al., 2023).The cross-sectional study approach that has been selected gives an overview of the current situation of BDA use in Jordanian SMEs. The data is collected by using a cross-sectional methodology, so researchers can analyze the relationships and patterns throughout a certain period (Mukhlis et al., 2022). Throughout the study, data on factors including technology features, organizational features, and environmental factors at a particular point in time can be collected by using a cross-sectional design.

3.2 Sample

An extended TOE framework, as well as the perceived usefulness, was utilized to analyze the factors that influenced the adoption of BDA. These SMEs span across diverse industries such as manufacturing, retail, services, and technology. A sample of 200 SMEs was selected from the broader population. The sample was drawn using stratified random sampling methods to ensure representation across various industries and geographical locations within Jordan. The minimum number of valid responses was 385 according to the recommendations of Bougie and Sekaran (2019). Accordingly, the research tool was sent to 450 managers in chosen SMEs. Overall, 409 responses were received, however, they included 21 invalid responses as they were incomplete. Hence, the sample size used in data analysis was 388 responses constituting 86.2% response rate.

3.3 Measures

The study employed a survey as the research instrument, utilizing a structured, self-administered questionnaire to gather data on the influence of the TOE framework on perceived usefulness, subsequently influencing the adoption of BDA at SMEs in Jordan. The research tool was administered electronically through a provided link and distributed via email to the targeted sample. The questionnaire consisted of an introduction outlining the research objectives to secure informed consent from participants. It further comprised sections for demographic information, categorized as well as study-specific data. Demographic details were collected categorically, while the assessment of study variables was conducted using a five-point Likert scale. Technological factors were derived from various studies. The concept of relative advantage was adapted from Lutfi et al. (2022), while compatibility and complexity were adapted from Chen et al. (2015) and Lai et al. (2018), respectively. Top management support was selected as an organizational factor based on Lutfi et al. (2022). Environmental factors, such as competitive pressure items and security items, were adapted from Lai et al. (2018) and Gao and Li (2021), respectively. Perceived usefulness was adapted from Alsharo et al. (2020). Lastly, the BDA adoption was adapted using three items from Lutfi et al. (2022). Furthermore, the study utilizes Structural Equation Modeling (SEM), recognized for its effectiveness in examining the connections between independent and dependent variables(Al-Momani, 2022), and conducts the analysis using AMOS software.

4. Results

4.1 Reliability and Validity

As part of the validation of the measurement model's psychometric properties, the reliability, convergent validity, and discriminant validity of the model were evaluated using Confirmatory Factor Analysis (CFA). The findings related with validity and reliability, as well as the descriptive analysis results for each construct, is summarized in Table 1.

The findings of the Confirmatory Factor Analysis submit a thorough assessment of the measurement model's validity and reliability. Additionally, all constructs show strong internal consistency, as mentioned by Composite Reliability (CR) values exceeding the recommended threshold of 0.70, verifying the model's reliability(Muda et al., 2022). The factor loadings varied from 0.662 to 0.814, suggesting a positive relationship between the latent constructs and their components, as they were above the minimal value of 0.50(Cheung et al., 2023; Muda et al., 2022). The range of Average Variance Extracted (AVE) values, which show convergent validity, was 0.531 to 0.590. Clearly, the items within each construct effectively measure the underlying concept, as they exceed the recommended threshold of 0.50 (Harahap et al., 2022; Pallathadka et al., 2023).

Maximum shared variance (MSV) is utilized to approve discriminant validity. So, there should be more MSV values of each construct than Average Variance Expression (AVE). Each construct had a MSV ranging from 0.312 to 0.482, indicating distinctness, hence proving that they are measuring different underlying concepts, indicating that each construct differs from the others (Pallathadka et al., 2023). Therefore, the measurement model is too robust in terms of detecting differences between constructs. As a result, the square root of the AVE surpassed its threshold of 0.70 for each construct, far exceeding the correlation coefficients among the other constructs (Dirgiatmo, 2023).This study validates the measure's measurement properties and provides a solid foundation for subsequent analyses and interpretations within the study's framework, due to its high reliability, convergent validity and discriminant validity.

4.2 Descriptive Statistics

Table 1 encapsulated crucial descriptive statistics for each construct in the study, shedding light on the central tendencies and variabilities within the dataset.

Table 1
Measurement model assessment and descriptive analysis

Constructs and items	Loadings	AVE	MSV	√AVE	CR	M	SD	VIF
Relative advantage		**0.543**	**0.312**	**0.737**	**0.856**	**3.60**	**0.782**	**2.166**
RA1	0.724							
RA2	0.799							
RA3	0.731							
RA4	0.725							
RA5	0.702							
Compatibility		**0.573**	**0.375**	**0.757**	**0.801**	**3.65**	**0.714**	**2.469**
CA1	0.735							
CA2	0.772							
CA3	0.764							
Complexity		**0.551**	**0.344**	**0.742**	**0.785**	**3.70**	**0.902**	**2.715**
CX1	0.681							
CX2	0.788							
CX3	0.753							
Top management support		**0.533**	**0.415**	**0.730**	**0.820**	**3.51**	**0.914**	**2.268**
TMS1	0.715							
TMS2	0.764							
TMS3	0.728							
TMS4	0.711							
Competitive pressure		**0.590**	**0.385**	**0.768**	**0.812**	**3.54**	**0.715**	**2.692**
CP1	0.737							
CP2	0.814							
CP3	0.751							
Security		**0.531**	**0.426**	**0.729**	**0.819**	**3.74**	**0.814**	**2.814**
SE1	0.733							
SE2	0.719							
SE3	0.671							
SE4	0.788							
Perceived usefulness		**0.543**	**0.482**	**0.737**	**0.855**	**3.62**	**0.931**	**---**
PU1	0.741							
PU2	0.662							
PU3	0.793							
PU4	0.755							
PU5	0.727							
Big data analytics		**0.589**	**0.477**	**0.768**	**0.811**	**3.58**	**0.803**	**---**
BDA1	0.804							
BDA2	0.732							
BDA3	0.765							

Participants, on average, expressed a moderate level of agreement regarding the relative advantage, as indicated by a mean score of 3.60 and a standard deviation of 0.782. Compatibility received a slightly higher mean of 3.65, reflecting a moderately positive perception, with a standard deviation of 0.714 suggesting a consistent level of agreement among respondents. Complexity, perceived with a high mean of 3.70, exhibited greater variability in responses, reflected by a higher standard deviation

of 0.902. Top management support and competitive pressure received mean scores of 3.51 and 3.54, respectively, indicating moderate perceptions with some variability in responses. Security garnered a relatively higher mean of 3.74, suggesting a generally positive perception, with a standard deviation of 0.814 indicating some variability.

Besides, participants expressed a moderate level of agreement regarding the perceived usefulness, as indicated by a mean score of 3.62 and a standard deviation of 0.931. BDA received a slightly lower mean of 3.58, reflecting a moderately positive perception, with a standard deviation of 0.803 suggesting a consistent level of agreement among respondents. The Variance Inflation Factor (VIF) values for each construct, measuring potential multicollinearity, were generally below 3, affirming acceptable levels of independence among predictor variables (Aldaihani et al., 2023).

4.3 Hypothesis Testing Results

AMOS software was utilized to create a structural model, examining how the dimensions of the TOE framework affect the perceived usefulness to enhance the adoption of BDA. The outcomes of testing the model's structural validity, as depicted in Figure 6, reveal the goodness-of-fit indices.

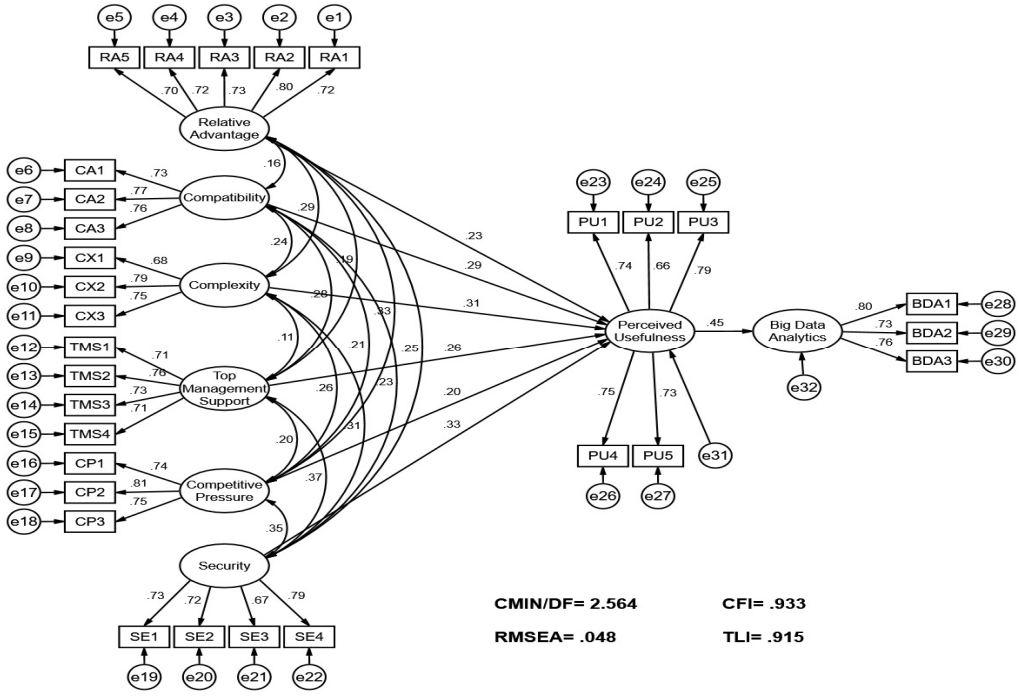

Fig. 6. SEM for the impact of TOE framework on big data analytics

The findings presented in Fig. 6 indicate that the CMIN/DF (2.564) fell below the established upper threshold of 3, as noted by Alkhlifat et al. (2023). The comparative fit index (CFI) was 0.933 and the Tucker-Lewis index (TLI) was 0.915, surpassing the minimum threshold of 0.90 for both indicators (Dwijendra et al., 2023). Additionally, the root mean square error of approximation (RMSEA) was 0.048, adhering to the permissible upper limit for this indicator of 0.08 as outlined by Zahran et al. (2023). Consequently, these results collectively support the conclusion that the structural model employed is structurally valid. Hence, the path coefficients used for hypothesis testing were reported in Table 2.

Table 2
Path coefficients for hypotheses testing

Hypothesis	Path			B	β	T
H1	Relative advantage	→	Perceived usefulness	0.245	0.233	3.88*
H2	Compatibility	→	Perceived usefulness	0.292	0.286	4.49**
H3	Complexity	→	Perceived usefulness	0.315	0.311	5.08***
H4	Top management support	→	Perceived usefulness	0.266	0.258	4.15**
H5	Competitive pressure	→	Perceived usefulness	0.213	0.205	3.49*
H6	Security	→	Perceived usefulness	0.334	0.329	5.56***
H7	Perceived usefulness	→	Big data analytics	0.467	0.452	6.87***

Note: *p< 0.05, **p< 0.01, ***p< 0.001.

The outcomes of the path analysis underscore the substantial impact of various factors on the adoption of BDA. Relative Advantage, with a path coefficient (B) of 0.245 and a standardized coefficient (β) of 0.233, demonstrates a statistically

significant positive relationship with perceived usefulness ($T = 3.88$, $p < 0.05$). Compatibility exhibits a robust influence, with a path coefficient of 0.292, a standardized coefficient of 0.286, and a highly significant T-value of 4.49 ($p < 0.01$). Complexity displays a notable impact, evidenced by a path coefficient of 0.315, a standardized coefficient of 0.311, and a highly significant T-value of 5.08 ($p < 0.001$). Top management support contributes significantly, with a path coefficient of 0.266, a standardized coefficient of 0.258, and a significant T-value of 4.15 ($p < 0.01$). Competitive pressure influences perceived usefulness, as indicated by a path coefficient of 0.213, a standardized coefficient of 0.205, and a significant T-value of 3.49 ($p < 0.05$). Security exhibits a robust impact, with a path coefficient of 0.334, a standardized coefficient of 0.329, and a highly significant T-value of 5.56 ($p < 0.001$). Importantly, Perceived usefulness significantly impacts BDA, with a path coefficient of 0.467, a standardized coefficient of 0.452, and a highly significant T-value of 6.87 ($p < 0.001$).

5. Discussion and Conclusion

5.1 Research Implications

Several important theoretical implications are presented in this study. Firstly, to gain a deeper understanding of BDA adoption in SMEs, this paper emphasizes the importance of merging the TOE framework with the DOI theory. As opposed to TOE's internal organizational factors, this approach moves beyond those to encompass more technological attributes, a focal point of DOI, which drives technology adoption. Secondly, the integration of perceived effectiveness in the TOE framework demonstrates how user perceptions play a crucial role in technology adoption. It posits that perceived effectiveness and practicality play a vital role in technology adoption, which has broader potential than just BDA as a topic for exploration. As a final point, this study argues that existing technology adoption models may need to be modified or enhanced to fully understand the complexity of adopting newer, advanced technologies like BDA. Besides, more detailed examination of how these factors interact might be essential. Also, this may require the inclusion of new variables.

5.2 Practical Implications

In this study, the impact of BDA adoption on Jordanian SMEs is significant. In the first place, Jordan's commitment to technological advancement and innovation suggests that SMEs should adopt BDA. In addition, combining the TOE and DOI frameworks offers a comprehensive approach to analyzing factors that affect BDA adoption within SMEs, enabling a roadmap to assess readiness and adoption prospects. Finally, to promote the adoption of BDA, it is emphasized that policymakers and SMEs should stress the tangible benefits of BDA.

5.3 Limitations and Future Directions

The study's focus is on the adoption of emerging technologies in Jordan. While the study provides useful insights, its focus on a specific spot may not entirely apply to other international environments, particularly those with different economic, cultural, and technological foundations. Forthcoming research should comprise reviewing these features in other geographical locations to broaden the grasp of technology adoption. Furthermore, the study's focus on BDA throughout SMEs which may exclude other critical variables of technology adoption that are applicable to larger organizations or alternative new technologies. Extending the research to encompass a wide range of developing technologies in both SMEs and larger organizations would provide a more comprehensive perspective of current technology growth and the inherent issues they pose.

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