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The role of business intelligence in enhancing e-commerce development: The mediating effect of digital transformation

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Abstract

This study examines the mediating role of digital transformation (DT) in the relationship between business intelligence (BI) and e-commerce development (ECD). Using survey data from 239 organizations in the Middle East and North Africa (MENA) region and applying partial least squares structural equation modeling (PLS-SEM), the findings confirm strong measurement reliability and significant structural relationships. Results indicate that BI positively influences both DT and ECD, while DT directly enhances e-commerce outcomes. DT partially mediates the BI–ECD relationship, and management support exerts a fully mediated effect through DT. In contrast, BI infrastructure and data collection alone show limited impact unless embedded within comprehensive digital transformation strategies. The study highlights BI as a strategic enabler rather than merely a technical resource, emphasizing the importance of leadership commitment, organizational readiness, and cultural alignment. Theoretically, it integrates the Technology–Organization–Environment (TOE) framework with the dynamic capabilities perspective. Practically, it offers guidance for managers and policymakers seeking to align BI investments with digital transformation initiatives to achieve sustainable e-commerce growth. Overall, the findings underscore the role of BI and DT in fostering resilience.

Keywords: Business intelligence, Digital transformation, E-commerce development, Digital sustainability, Mediating effects, Dynamic capabilities

1. Introduction

The rapid expansion of online retail has transformed the global business environment, positioning e-commerce as a dominant and irreversible mode of business activity. This digital shift generates vast amounts of transactional and behavioral data, requiring advanced analytical models such as Business Intelligence (BI) to

extract meaningful insights and inform strategic decisions [1], [2]. Conventional data management methods are inadequate for handling such complexity, reinforcing the importance of BI in enabling firms to personalize customer experiences, enhance operations, and improve market responsiveness [3], [4]. As part and parcel of the entire sustainable agenda of digitalization, the convergence of DT and BI enables inclusive development within the economy and effective resource allocation and knowledge-based value creation, all aligned with plans oriented towards sustainability and digital heritage ecosystems preservation.

BI is particularly vital for small and medium-sized enterprises (SMEs), where integration with e-commerce can drive scalability and competitiveness in digitally empowered economies [5], [6]. However, the strategic value of BI is often unlocked only when embedded within a broader digital transformation (DT) strategy that aligns emerging technologies, agile processes, and organizational culture [7], [8]. Despite increasing scholarly attention to BI and DT as separate constructs, limited empirical research examines their joint impact on e-commerce outcomes. Previous research investigated digitalization in SMEs without modeling DT as a mediator, while others explored corporate governance and sustainability but did not address BI–DT interactions [9], [10]. Similarly, another research highlighted the role of AI in e-business, yet overlooked BI's integration within DT strategies [11]. These gaps underscore the need for a more comprehensive empirical analysis that accounts for BI, DT, and their combined influence on e-commerce development.

This study addresses this gap by examining the mediating role of DT in the relationship between BI and e-commerce development. Guided by the Technology–Organization–Environment (TOE) framework, the study incorporates BI dimensions (data collection, analysis, infrastructure, and management support) and links them with DT and e-commerce outcomes [12], [13]. This approach provides a nuanced understanding of how organizations can strategically leverage BI capabilities through digital transformation to generate measurable e-commerce value.

To achieve this aim, the study is guided by the following research questions:

- **RQ1:** To what extent does BI directly influence e-commerce development?
- **RQ2:** Does DT mediate the relationship between BI and e-commerce development?

Based on the theoretical framework, the following hypotheses are proposed:

- **H1:** BI positively influences DT.
- **H2:** BI positively influences e-commerce development.
- **H3:** DT positively influences e-commerce development.
- **H4:** DT mediates the relationship between BI and e-commerce development.
- **H5:** Management support enhances DT, which in turn improves e-commerce development.

By explicitly positioning DT as a mediator, this study contributes to the literature on BI and e-commerce by clarifying the mechanisms through which BI capabilities translate into digital business success. It further responds to calls for more evidence-based research in emerging markets, where digital readiness and leadership commitment are essential for shaping sustainable e-commerce trajectories.

2. Literature review and theoretical framework

2.1. E-commerce development

E-commerce has emerged as a transformative force in global business, reshaping how value is created, exchanged, and sustained. Beyond enabling online transactions, e-commerce platforms integrate marketing, logistics, payments, and customer service into comprehensive digital ecosystems [14], [15]. As digital adoption accelerates, firms increasingly leverage artificial intelligence, cloud-based tools, and machine learning to personalize experiences, enhance operational efficiency, and expand market reach [16], [17].

At the same time, e-commerce raises challenges around trust, data ethics, and regulatory compliance. Issues such as privacy, algorithmic transparency, and cybersecurity influence consumer confidence and, by extension, business sustainability [18], [19], [20]. Scholars emphasize that digital sales growth alone is insufficient; sustainable e-commerce requires a balance between technological capability and ethical governance [21].

2.2. Business intelligence (BI)

BI is commonly defined as a set of processes, technologies, and practices that transform raw data into actionable insights for decision-making [22], [23]. It encompasses data warehousing, data mining, visualization, and predictive analytics, enabling organizations to identify opportunities, optimize supply chains, and enhance consumer engagement [24], [25]. BI's value lies in converting complex datasets into strategic intelligence that supports both short-term efficiency and long-term competitiveness.

However, BI success is not automatic. Adoption often fails when firms lack digital maturity, leadership commitment, or an organizational culture supportive of data-driven decision-making [26]. SMEs, in particular, frequently underutilize BI tools due to limited financial resources or insufficient integration into strategic planning [27]. Furthermore, BI data itself can introduce risks. Incomplete datasets, biased algorithms, or privacy breaches can distort insights, potentially eroding consumer trust in e-commerce environments [28]. Such challenges illustrate that BI, while powerful, is insufficient in isolation; it must be embedded within larger organizational and technological frameworks.

2.3. Business intelligence and e-commerce development

The integration of BI into e-commerce operations has been shown to improve decision-making, enhance personalization, and drive operational efficiencies [29]. Firms employing BI can identify behavioral patterns, optimize pricing, and forecast demand with greater accuracy. For example, advanced data analytics enables e-commerce businesses to track consumer journeys, predict churn, and deliver targeted promotions that improve both conversion rates and customer satisfaction [30].

Yet, empirical evidence also highlights BI's limitations when used without complementary digital transformation. BI infrastructure alone rarely translates into measurable e-commerce development if organizations fail to embed it within strategic change processes [31]. Several studies show that companies with substantial BI investments often report limited ROI due to siloed implementation and weak cultural adoption [32]. Conversely, firms that integrate BI within broader DT initiatives report stronger outcomes, such as increased customer loyalty, faster adaptation to market shifts, and improved innovation capacity. This suggests that BI acts as a catalyst, but its potential is fully realized only when combined with organizational agility and digital readiness.

2.4. Digital transformation (DT) as a mediator

DT extends beyond technology adoption to encompass organizational agility, process reengineering, and cultural change [33]. It reflects a holistic approach to integrating technologies such as AI, IoT, and blockchain while simultaneously reshaping organizational structures and customer engagement models. DT enables firms to move from reactive to proactive strategies, ensuring that data insights translate into tangible performance outcomes.

In this context, DT serves as a mediating mechanism that converts BI capabilities into e-commerce value. For instance, data collection and analysis may reveal customer trends, but without agile processes and digitally enabled systems, firms cannot act effectively on these insights. Similarly, BI infrastructure provides the foundation for data storage and processing, but only when coupled with digital strategies does it generate customer-centric outcomes.

The Technology–Organization–Environment (TOE) framework provides a useful lens to analyze this process [34-36]. From a technological perspective, BI represents a set of tools and infrastructures, while DT represents the broader platform that operationalizes these insights. From an organizational perspective, management

support and digital culture determine whether BI insights are strategically deployed. From an environmental perspective, regulatory pressures, competitive intensity, and consumer expectations push firms to integrate BI into comprehensive digital transformation agendas [38]. While the digital transformation journey in the MENA and GCC countries shows strong government-driven initiatives and rapid e-commerce evolution, the same transitions are witnessed globally. For instance, firms in advanced economies are increasingly adopting the use of BI and DT tools with a view to fostering resilience and sustainability for post-pandemic recovery policies [39].

Likewise, studies in the European Union and Asia underline that the dynamic capability to transform digital infrastructures is a main source of competitive advantage [36], [40]. These global findings attest to the universality of the TOE and dynamic capabilities frameworks while highlighting regional variations in digital preparedness and policy support. For example, evidence from advanced economies shows that the integration of business intelligence and digital transformation systems enhances organizational resilience, strategic adaptability, and long-term sustainability in post-pandemic contexts [37], [41]. Similarly, empirical evidence from European and Asian firms indicates that strong dynamic digital capabilities enable continuous innovation, improved resource efficiency, and industrial transformation aligned with SDG 9 (Industry, Innovation, and Infrastructure) [42- 44].

2.5. Theoretical integration: TOE and dynamic capabilities

While TOE explains the structural enablers of BI and DT adoption, the dynamic capabilities (DC) perspective enriches the model by highlighting how organizations adapt and reconfigure resources in turbulent environments. BI provides the sensing capacity to detect opportunities and threats, DT provides the seizing capacity to act on insights, and organizational agility represents the reconfiguring capacity to sustain advantage [45]. Together, TOE and DC suggest that BI and DT should not be viewed as static tools but as evolving capabilities that drive continuous e-commerce development. From the sustainability viewpoint, the TOE and Dynamic Capabilities models combine adaptive resource configuring and digital creativity as the most critical elements required to ensure organizational and economic sustainability amidst turbulent markets [46], [47], [48]. This theoretical integration clarifies why BI may fail in non-digitally mature firms: without dynamic capabilities and environmental alignment, data insights remain underutilized [49]. It also explains why leadership support is essential for executives enable the reconfiguration of processes, resources, and culture that make DT effective [50], [51].

3. Methodology

This study adopted a quantitative research design to examine the mediating role of digital transformation (DT) in the relationship between business intelligence (BI) and e-commerce development (ECD). Partial least squares structural equation modeling (PLS-SEM) was employed due to its suitability for complex mediation models, its robustness with medium sample sizes, and its ability to analyze constructs measured with multiple indicators. Following Hair et al. [52], the analysis was conducted in two stages: first, the measurement model was evaluated for reliability and validity, and second, the structural model was assessed to test the hypothesized relationships.

The target population comprised professionals, managers, and frequent users engaged in e-commerce activities across Middle Eastern and GCC countries. An online survey was administered in both Arabic and English between April and June 2025. Out of 400 distributed questionnaires, 239 valid responses were retained for analysis, yielding a response rate of 59.7%. The sample was diverse, including participants from retail, banking, education, and logistics sectors, reflecting the heterogeneous nature of the regional e-commerce ecosystem.

Survey items were adapted from validated scales in prior studies. BI was measured across four dimensions: data collection, data analysis, BI infrastructure, and management support [53]. DT items focused on technology adoption, organizational agility, and digital infrastructure readiness [37], [39], while ECD was assessed through measures of service quality, reliability, responsiveness, and customer satisfaction [54], [55]. All items were measured using a five-point Likert scale ranging from *Strongly Disagree (1)* to *Strongly Agree (5)*.

Participation in the study was voluntary, with informed consent obtained prior to survey completion. Anonymity and confidentiality were assured, and no personally identifiable information was collected. Since the study addressed non-sensitive topics, formal ethical approval was not required, which is consistent with standard practices in survey-based business research.

The data were analyzed using SmartPLS 4.0. The measurement model demonstrated satisfactory reliability, with Cronbach's alpha and composite reliability values exceeding 0.70, and convergent validity confirmed by average variance extracted (AVE) values above 0.50. Discriminant validity was verified using both the Fornell–Larcker criterion and the Heterotrait–Monotrait ratio (HTMT). Two items (DC3 and DT1) were dropped due to low factor loadings (<0.70). The structural model was then tested using bootstrapping with 5,000 resamples, and path coefficients, t-statistics, and p-values were reported with standardized formatting. Model fit indices (SRMR < 0.08) indicated acceptable fit, while the R^2 values demonstrated that BI and DT jointly explained more than 60% of the variance in e-commerce development.

To ensure the robustness of the findings, variance inflation factor (VIF) values were assessed and found to be below 3.3, indicating no multicollinearity issues. Sensitivity analyses were also conducted by re-estimating the model after excluding non-significant paths (e.g., BI infrastructure → ECD, Data Analysis → ECD). The results remained consistent, confirming the stability and robustness of the mediation effects.

4. Data analysis and results

Data analysis was conducted using SmartPLS 4.0 with partial least squares structural equation modeling (PLS-SEM), which is suitable for complex mediation models and latent constructs. With 239 valid responses, PLS-SEM provided adequate statistical power and flexibility for evaluating both the measurement and structural models. Following Hair et al. [52], the analysis was conducted in two stages: first, the measurement model was assessed, and second, the structural model was evaluated.

Reliability and validity tests confirmed that all constructs were acceptable. Cronbach's alpha and composite reliability values exceeded the recommended threshold of 0.70, and average variance extracted (AVE) values were above 0.50, demonstrating convergent validity. Discriminant validity was confirmed through the Fornell–Larcker criterion and the Heterotrait–Monotrait ratio (HTMT). Two items (DC3 and DT1) were dropped due to low loadings below 0.70, while the remaining items ranged from 0.713 to 0.883, indicating strong construct representation.

Table 1 reports the results of validity and reliability. The values indicate that BI, DT, and ECD constructs achieved acceptable reliability and validity, while R^2 values show that BI and DT explain a substantial proportion of the variance in e-commerce development.

Table 1. Validity and reliability

Code	Variables	Loading	CA	CR	AVE	R^2
BII1	BI infrastructure	0.728	0.786	0.861	0.607	
BII2		0.832				
BII3		0.791				
BII4		0.763				
DA1	Data Analysis	0.722	0.722	0.826	0.543	
DA2		0.732				
DA3		0.726				
DA4		0.767				

Code	Variables	Loading	CA	CR	AVE	R^2
DC1	Data Collection	0.889	0.813	0.890	0.730	
DC2		0.884				
DC4		0.786				
DT2	Digital Transformation	0.713	0.817	0.880	0.647	0.668
DT3		0.796				
DT4		0.840				
DT5		0.861				
EC1	E-Commerce Development	0.808	0.824	0.877	0.587	0.615
EC2		0.753				
EC3		0.748				
EC4		0.793				
EC5		0.727				
MS1	Management Support	0.820	0.815	0.877	0.642	
MS2		0.772				
MS3		0.848				
MS4		0.762				

Figure 1 presents the measurement model, which illustrates the factor loadings and latent variable relationships. Discriminant validity was further assessed using the HTMT procedure as recommended [53]. The results are shown in Table 2, where all values remained within acceptable limits, confirming discriminant validity.

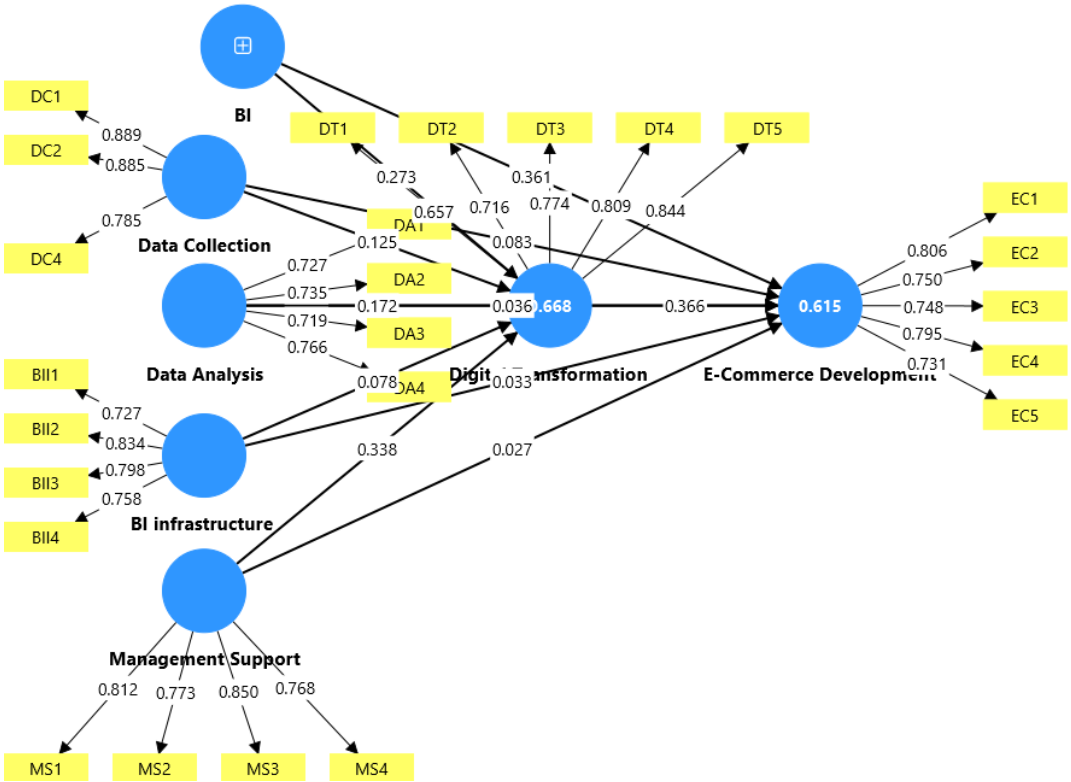

Figure 1. Measurement model

To further ensure that the constructs were empirically distinct, discriminant validity was tested. As recommended by Henseler et al., the Heterotrait–Monotrait ratio (HTMT) was applied in addition to the Fornell–Larcker criterion. The results, shown in Table 2, indicate that all HTMT values were below the conservative threshold of 0.85, confirming that each construct captures a unique dimension of the model and that multicollinearity concerns were minimal.

Table 2. Discriminant validity using HTMT

Variables	BI	BI infrastructure	Data Analysis	Data Collection	Digital Transformation	E-Commerce Development	Management Support
BI	-	-	-	-	-	-	-
BI infrastructure	0.531	-	-	-	-	-	-
Data Analysis	0.716	0.844	-	-	-	-	-
Data Collection	0.628	0.542	0.806	-	-	-	-
Digital Transformation	0.797	0.634	0.828	0.750	-	-	-
E-Commerce Development	0.832	0.557	0.730	0.665	0.864	-	-
Management Support	0.709	0.680	0.846	0.794	0.819	0.729	-

The structural model was then tested using bootstrapping with 5,000 resamples. Model fit indices were acceptable (SRMR < 0.08), and the R^2 values confirmed strong explanatory power. As shown in Table 3, BI significantly influenced DT ($\beta = 0.306$, $p < 0.001$) and ECD ($\beta = 0.351$, $p < 0.001$), while DT significantly impacted ECD ($\beta = 0.353$, $p < 0.001$). These results demonstrate the partial mediating role of DT. However, not all BI dimensions contributed equally. BI infrastructure and data analysis did not show significant direct effects on ECD, suggesting that technical tools and analytical capacity alone are insufficient unless strategically embedded in broader transformation initiatives.

Table 3. Hypothesis result

Path	β	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Result
BI -> Digital Transformation	0.306	0.065	4.743	0.000	Supported
BI -> E-Commerce Development	0.351	0.062	5.614	0.000	Supported
BI infrastructure -> Digital Transformation	0.073	0.074	0.984	0.326	Not Supported
BI infrastructure -> E-Commerce Development	0.039	0.067	0.588	0.557	Not Supported
Data Analysis -> Digital Transformation	0.169	0.081	2.102	0.036	Supported
Data Analysis -> E-Commerce Development	0.038	0.076	0.497	0.620	Not Supported
Data Collection -> Digital Transformation	0.163	0.076	2.143	0.033	Supported
Data Collection -> E-Commerce Development	0.070	0.059	1.184	0.237	Not Supported
Digital Transformation -> E-Commerce Development	0.353	0.078	4.546	0.000	Supported

Management Support -> Digital Transformation	0.241	0.081	2.964	0.003	Supported
Management Support -> E-Commerce Development	0.068	0.077	0.880	0.379	Not Supported

To further assess indirect effects, mediation analysis was conducted. Figure 2 presents the mediation model, illustrating both significant and non-significant paths across BI, DT, and ECD. This visual representation highlights the importance of DT as a bridging mechanism, showing where BI dimensions contribute directly and indirectly to e-commerce development.

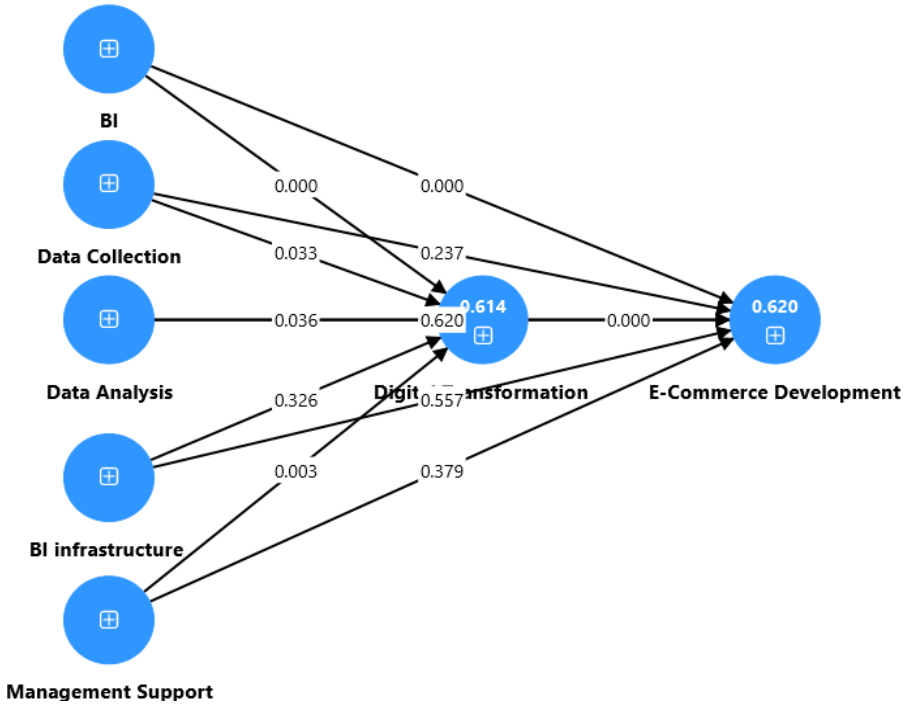

Figure 2. Mediation test

The detailed results are summarized in Table 4. BI demonstrated a significant indirect effect on ECD through DT ($\beta = 0.108$, $p = 0.002$), confirming partial mediation. Management support exerted full mediation ($\beta = 0.085$, $p = 0.011$), underscoring the role of leadership in fostering transformation. In contrast, BI infrastructure, data analysis, and data collection did not produce significant mediation effects, reinforcing the idea that infrastructure and raw data alone cannot create value unless accompanied by organizational readiness and strategic transformation.

Table 4. Mediation result

Path	β	T statistics (|O/STDEV|)	P values	Result
BI -> Digital Transformation -> E-Commerce Development	0.108	3.092	0.002	Partial mediate
BI infrastructure -> Digital Transformation -> E-Commerce Development	0.026	0.925	0.355	No mediation
Data Analysis -> Digital Transformation -> E-Commerce Development	0.060	1.950	0.052	No mediation
Data Collection -> Digital Transformation -> E-Commerce Development	0.057	1.874	0.062	No mediation

Management Support -> Digital Transformation -> E-Commerce Development	0.085	2.558	0.011	Full mediation

The non-significant direct effects of BI infrastructure, data analysis, and data collection on e-commerce development can be interpreted in light of contextual characteristics of the MENA region. In many organizations, digital maturity remains uneven, with BI initiatives often focused on technology acquisition rather than strategic integration into core business processes. Limited data-driven culture, hierarchical decision-making structures, and partial alignment between analytics outputs and managerial action reduce the likelihood that technical BI capabilities alone translate into observable performance outcomes. Such patterns are consistent with methodological guidance indicating that non-significant paths in PLS-SEM frequently reflect contextual constraints rather than model misspecification [53].

In contrast, evidence from more digitally mature regions such as OECD, European, and Asian economies suggests that BI capabilities exert stronger direct effects on performance due to higher levels of analytical integration, organizational agility, and digitally enabled decision routines. In these contexts, BI is typically embedded within enterprise-wide digital transformation strategies, enabling faster sensing and seizing of market opportunities. This contrast reinforces recent digital transformation research emphasizing that BI effectiveness is highly context-dependent and contingent on organizational readiness and cultural alignment [54].

Taken together, the results confirm that BI has a positive and significant effect on both DT and e-commerce development, but the strength of these effects remains moderate. The findings emphasize that BI becomes most effective when embedded within broader transformation strategies, supported by leadership and organizational agility. Non-significant paths further indicate that infrastructure and raw data capabilities alone do not create value unless leveraged through DT. These insights align with prior studies [56], [57] which stress the contingent role of DT in converting BI investments into tangible digital outcomes.

This implies that data capabilities are important but only exert substantial influence when accompanied by transformation strategies that reshape the way enterprises operate and serve customers. One of the most important findings was that management support had a significant indirect effect on e-commerce through DT ($\beta = 0.085$, $p = 0.011$), confirming that leadership does not directly contribute to e-commerce performance but creates the enabling environment for digital transformation to thrive. In short, these results reaffirm that DT is the mechanism that allows BI and leadership support to drive real change in e-commerce.

5. Discussion of the results

While the findings are robust, they should be interpreted with caution. The reliance on self-reported survey data introduces potential response bias, and the cross-sectional design limits the ability to draw causal inferences. Additionally, the study focuses on firms in Middle Eastern and GCC economies, which may restrict generalizability to more digitally mature markets. These limitations highlight opportunities for future research, including longitudinal studies and cross-regional comparisons to test the stability of these relationships.

The findings of this study provide robust empirical support for the mediating role of digital transformation (DT) in enhancing the impact of business intelligence (BI) on e-commerce development. The results reinforce an emergent paradigm in management research: BI, while valuable, is insufficient in isolation to guarantee digital business success. Its full potential is realized only when embedded within a broader digital transformation strategy. This aligns with past studies, such as [58], which emphasize that BI tools can generate insights but that organizations require digital maturity, integrated processes, and strategic readiness to act upon those insights effectively.

The study confirms that DT significantly mediates the relationship between BI and e-commerce outcomes, validating arguments that digital transformation promotes organizational responsiveness and agility capabilities essential for firms competing in volatile online environments [59]. These findings extend the literature by showing that BI is best conceptualized as an enabler whose effectiveness depends on how well it is integrated

into systemic digital initiatives. This suggests that firms must not only invest in advanced analytics but also cultivate organizational competencies, leadership support, and infrastructure that support continuous adaptation and reconfiguration.

The application of the Technology-Organization-Environment (TOE) framework in this study offered valuable explanatory power. Consistent with [9], the results highlight that BI initiatives achieve significant performance benefits only when organizational readiness and contextual alignment are present. Moreover, the study found that certain components of BI, such as data collection and infrastructure, did not show significant direct effects on e-commerce performance. This aligns with emerging evidence that while these capabilities form a necessary foundation, they remain non-transformative unless orchestrated through broader digital strategies [60].

From a theoretical perspective, the results support the view that digital transformation operates as a dynamic capability bridging BI resources and e-commerce outcomes by enabling firms to sense, seize, and reconfigure opportunities in fast-changing markets. Without cultural adaptation, leadership commitment, and process re-engineering, raw data capabilities remain underutilized and fail to generate meaningful competitive advantage. The essential role of management support, which exerted a full mediation effect through DT, underscores leadership's critical influence in enabling transformation. This finding is consistent with research demonstrating that active involvement of senior management is necessary to facilitate structural alignment, change readiness, and the allocation of strategic resources [61].

For practice, these findings suggest that managers must approach BI not as a stand-alone technical tool but as part of a comprehensive digital transformation strategy. Leadership commitment is particularly vital; managers must champion digital initiatives, integrate analytics into both operational and customer-facing processes, and foster a culture of data-driven decision-making. This requires not only investment in technology but also investments in people, processes, and governance structures that sustain agility and innovation.

Overall, this study contributes to the growing body of research emphasizing that BI's impact on e-commerce development is not purely technical but deeply strategic. DT serves as the catalyst that converts analytical potential into tangible business value. By integrating BI within transformation strategies, firms can achieve sustainable digital growth, enhanced customer centricity, and improved competitive positioning. For academics, the findings underscore the importance of examining BI within multi-theoretical frameworks such as TOE and dynamic capabilities. For practitioners, the results highlight that digital leadership and organizational readiness are as important as technological capability in ensuring BI investments yield lasting impact.

6. Conclusion and future research

6.1. Conclusion

This study examined the mediating role of digital transformation (DT) in the relationship between business intelligence (BI) and e-commerce development (ECD). Using PLS-SEM and survey data from 239 organizations in Middle Eastern and GCC economies, the results showed that BI significantly influences both DT and ECD, while DT itself exerts a direct positive effect on e-commerce outcomes. Importantly, DT partially mediated the BI–ECD relationship, and management support exerted a full mediation effect through DT, emphasizing the pivotal role of leadership in fostering digital initiatives. By contrast, BI infrastructure and data collection were not significant predictors of ECD when assessed independently, reinforcing the argument that technological capacity must be embedded in broader transformation strategies to yield business value.

These findings underscore that BI is not merely a technical function but a strategic enabler. Its impact is contingent upon organizational readiness, leadership commitment, and cultural adaptation, with DT serving as the mechanism that converts analytical potential into sustainable digital performance. Through the combination of DT and BI through sustainable digital strategies, organizations boost performance alongside other broad sustainable development targets (SDGs), including innovation, responsible consumption, and infrastructure resilience (SDG 9 and SDG 12).

6.2. Theoretical and practical contributions

From a theoretical perspective, this research advances understanding by integrating the Technology–Organization–Environment (TOE) framework with the dynamic capabilities perspective. The results highlight that DT acts as both a mediator and a dynamic capability, enabling organizations to sense opportunities, seize them through data-driven insights, and reconfigure resources in dynamic e-commerce markets. This contributes to a more nuanced understanding of how BI capabilities interact with organizational and environmental contexts to generate value.

From a practical perspective, the study provides actionable insights for managers and policymakers. For managers, the findings emphasize that BI investments should not be treated as stand-alone projects but must be coupled with leadership-driven transformation initiatives that foster agility, customer centricity, and innovation. For policymakers, the study highlights the importance of national digital agendas that not only promote technological adoption but also strengthen organizational capabilities and managerial skills required to sustain transformation at scale.

6.3. Limitations and future research

While the findings are robust, they should be interpreted with caution. The reliance on self-reported survey data introduces the possibility of response bias, and the cross-sectional research design limits causal inference. To mitigate these concerns and enhance methodological rigor, several procedural controls were implemented during data collection. Participation was strictly voluntary, and respondents were assured complete anonymity and confidentiality. The bilingual (Arabic–English) questionnaire was validated using a back-translation procedure and expert review to ensure semantic equivalence and cross-cultural reliability. In addition, a pilot study involving 25 participants drawn from the target population of e-commerce professionals and users was conducted to assess item clarity, relevance, and internal consistency. Feedback from the pilot phase resulted in minor refinements to wording and construct alignment prior to full-scale deployment, thereby reducing potential response bias and common-method variance. Despite these safeguards, the generalizability of the findings remains constrained by the regional focus on MENA and GCC economies, which may differ in digital maturity from other contexts. Future research could address this limitation through cross-regional and longitudinal comparative studies, as well as industry-specific analyses, to further validate the robustness and transferability of the proposed BI–DT–e-commerce framework across diverse digital environments.

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Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

The contribution to the paper is as follows: Saed Adnan Mustafa, Abeer F. Alkhwaldi: study conception and design; Wissam Y. Khabashna, Ala'a Mohammed Al-Junaidi: data collection; Wissam Y. Khabashna, Ala'a Mohammed Al-Junaidi: analysis and interpretation of results; Saed Adnan Mustafa, Ibrahim A. Abu-AlSondos,

Anas A. Salameh, Abeer F. Alkhwaldi: draft preparation. All authors approved the final version of the manuscript.

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