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From VUCA to sustainability: The mediating role of digital leadership and the moderating role of digital organizational culture in SMEs

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Abstract: This paper discusses how external VUCA, such as volatility, uncertainty, complexity, and ambiguity, influence digital leadership and how digital leadership supports sustainable performance in small and medium-sized enterprises (SMEs). Based on data gathered from SME managers and analyzed using PLS-SEM, the findings reveal that all four VUCA dimensions have a significant negative impact on digital leadership, indicating that environmental turbulence limits leaders' capacity to initiate digital transformation. Digital leadership has a high positive impact on sustainable performance which shows the position of digital leadership as a leading factor that boosts outcomes of innovation, operational efficiency and sustainability. Additionally, digital organizational culture acts as an important moderator in the relationship between digital leadership and sustainable performance, suggesting that cultural preparedness enhances leadership effectiveness. The results contribute to the understanding of VUCA and digital transformation by establishing the connection between environmental context, leadership capacity, and organizational culture as an integrated system. Practical implications emphasize the importance of capability building, cultural strengthening, and strategic resilience to help SMEs maintain performance in dynamic environments.

Keywords: *Digital leadership, Digital organizational culture, SMEs, Sustainable performance, VUCA environment.*

1. Introduction

Nowadays, small and medium-sized enterprises (SMEs) operate under conditions increasingly influenced by Volatility, Uncertainty, Complexity, and Ambiguity (VUCA), a concept that has become a popular trend in management research to explain turbulent and unpredictable business conditions [1]. In the context of emerging economies like Qatar, the pressures of VUCA are intensified by rapid technological changes, regulatory shifts, and evolving customer demands, which destabilize planning activities and strategic decision-making processes of SMEs [2, 3]. The instability of market needs and legislative changes are driving forces that require SMEs to activate their strategies on a regular basis [4]. The uncertainty caused by unpredictable technological and economic changes limits the effectiveness of leaders in making predictions and distributing funds [5]. The complexity of globalization, digital convergence, and emerging customer expectations makes the variables leaders must handle interdependent [6]. Ambiguity, arising from vague or insufficient data regarding digital transformation and sustainability, presents additional challenges for leaders in making sound strategic decisions [7].

In such circumstances, digital leadership has become one of the essential competencies that can help SMEs to feel the changes in the environment, react swiftly, and use digital technologies to stay competitive [8, 9]. Digital leadership encompasses not just embracing technology but also becoming innovative, leading the digital strategy, and making digital initiatives consistent with organizational objectives [10]. Empirical data demonstrate that robust digital leadership increases the capacity of SMEs to be sustainable (in terms of process efficiency, the use of data in decision-making, and

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innovation) [8, 11]. Digital leadership has therefore turned out to be a strategic contributor to sustainable performance involving economic, environmental, and social aspects of organizational performance [12].

Nevertheless, VUCA states may undermine leadership performance by causing decision ambiguity, information oversaturation, and resource limitations. As shown in your thesis results, volatility, uncertainty, complexity, and ambiguity negatively impact digital leadership, making it challenging to lead digital transformation in turbulent environments [3].

This highlights the necessity of having organizational mechanisms that enhance leadership impact. Digital organizational culture is a major enabler, defined as shared values that facilitate the use of technology, collaboration, and experimentation [13]. This culture improves employees' digital preparedness, minimizes resistance to change, and makes digital strategy implementation easier. The research proved that digital organizational culture has a beneficial moderating effect on the relationship between digital leadership and sustainable performance, enabling SMEs to transform leadership vision into long-term sustainability results even under VUCA pressures.

This research gives a complete framework by covering VUCA factors, digital leadership and digital organizational culture as to how SMEs in emerging economies can attain sustainable performance during turbulence in the environment.

1.1. Research Questions

This study explores how external VUCA factors, volatility, uncertainty, complexity, and ambiguity, shape digital leadership in SMEs and examines how such leadership, supported by a digital organizational culture, translates into sustainable performance under dynamic environmental pressures.

1.2. Research Objectives

This study aims to develop an integrated empirical framework examining how external VUCA factors, volatility, uncertainty, complexity, and ambiguity, shape digital leadership in SMEs, investigate its direct impact on sustainable performance, and analyze how digital organizational culture enhances the translation of digital leadership into sustainability outcomes under VUCA conditions.

2. Literature Review

The current wave of digitalization in business environments has sparked academic interest, where the external environment influences organizational potential, particularly digital leadership [14]. Increasing volatility, uncertainty, complexity, and ambiguity, characteristic of VUCA conditions, introduce disruptive forces that challenge organizations' ability to maintain a competitive advantage [15]. Shifting regulatory frameworks, market uncertainties, and digital policy changes compel SMEs to continually realign operational strategies, thereby undermining control and predictability in leadership [4]. This ambiguity, driven by unstable technological protocols and economic fluctuations, restricts leaders' capacity to forecast trends and engage in long-term planning [5]. The processes that are interconnected create complexity and globalizing value chain would place leaders in the cognitive burdens of interpreting numerous interdependent variables [6]. Additionally, ambiguity hampers decision-making by creating vague causal relationships and uncertainties related to digital transformation and sustainability [7]. Collectively, these VUCA dimensions have been shown to negatively impact digital leadership, rendering leaders ineffective in digital transformation efforts.

At the same time, the literature defines digital leadership as one of the strategic capabilities required to surmount digital transformation. Digital leadership refers to an integration of technological vision, number-oriented decision-making, and mobilization of digital resources, which is aimed at guaranteeing innovation and resilience [8, 10]. The Resource-Based View theorizes digital leadership as a high-level capacity to align digital resources, i.e., digital maturity, digital processes, and technological skills, with strategic organizational objectives [16]. Empirical studies are unanimous in observing that digital leadership is positively linked to sustainable performance by improving operational efficiency, enabling

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innovation, and promoting responsible and eco-friendly practices [12]. It is particularly essential for SMEs in emerging markets, where digitization is the pathway to long-term competitiveness and sustainability.

However, digital leadership can be successful only based on internal cultural preparedness. A good digital organizational culture is critical to transforming leadership initiatives into valuable, sustainable deliverables due to its openness, technological passion, curiosity, and successful knowledge sharing [13]. Digital culture also reduces resistance to change, digital literacy, and technology adoption rates at organizational levels [17]. Findings of your thesis affirm that digital organizational culture positively moderates the relationship between digital leadership and sustainable performance, enhancing leadership impact in VUCA pressures.

This justifies other comprehensive literature that asserts that culture is a dynamic, enabling process to improve the effectiveness of digital strategies [18]. Overall, the earlier literature emphasizes the interdependence of external VUCA variables, digital leadership capabilities, and internal cultural readiness in determining the sustainable performance of SMEs.

2.1. Hypotheses Development

2.1.1. Volatility Negatively Influences Digital Leadership

Volatility is the rate and frequency of change in the external environment, especially in markets, regulations, and technology [15]. High volatility in the case of SMEs makes operations unstable, interrupts the planning process, and compels leaders to respond quickly with incomplete information [4]. Leaders also find it difficult to be strategic and invest resources in long-term digital activities in such environments. Volatility contributes to uncertainty regarding technological investments because leaders are reluctant to implement innovative solutions and invest in digital transformation projects that could soon become outdated [19]. The ever-changing conditions, including shifting customer needs, unexpected regulatory reforms, and rapid changes in digital policies, restrict leaders' capacity to guide their organizations toward consistent digital strategies [20]. The findings in the thesis reveal that volatility has a significant adverse effect on digital leadership, as leaders are preoccupied with survival-based immediate decisions rather than making decisions aimed at future digital transformation.

As a result, unstable situations undermine leaders' ability to articulate a consistent digital vision, bring teams together behind innovation, and create trust in digital investments.

H_1. Volatility negatively influences digital leadership in SMEs.

2.1.2. Uncertainty Negatively Influences Digital Leadership

The uncertainty is considered to occur when the external environment implies some unpredictable changes, lack of information, or uncertainty of the digital future, which deprives leaders of predicting the tendencies or choosing the best possible courses of action [5]. SME leaders can face challenges in assessing digital opportunities, selecting the right technological solutions, and connecting digital initiatives with long-term sustainability goals in highly uncertain environments. Uncertainty also leads to the perception of risks when adopting digital solutions, resulting in slower decision-making and less confidence in leadership [19]. When leaders lack quality data regarding market direction, technological development, or regulatory outcomes, they tend to be conservative and hesitant to implement innovative digital projects that may require extensive investment [21]. The research findings highlight the importance of uncertainty as a major constraint of digital leadership because it limits leaders' capacity to establish priorities, make correct decisions, and motivate teams to work with digital technologies.

Consequently, uncertainty produces circumstances where digital leadership is responsive rather than proactive, thus diminishing its influence on strategy.

H_2. Uncertainty negatively influences digital leadership in SMEs.

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2.1.3. Complexity Negatively Influences Digital Leadership

Complexity is defined as the quantity of interdependent variables managers must pay attention to when making decisions simultaneously: technological systems, customer needs, operational processes, or stakeholder expectations [6]. With increased integration of digital technologies in business functions, SMEs face more information, advanced systems, and complex decision-making processes [22]. This adds cognitive load to leaders, making it difficult to prioritize, coordinate, and implement digital strategies. Complexity also reduces leaders' capacity to interpret digital trends clearly, especially when multiple technologies are involved and cannot be easily predicted [23]. This research demonstrates that the negative effect of complexity on digital leadership is significant because leaders struggle to address multi-dimensional problems, coordinate digital processes, and maintain strategic consistency amid growing technical and organizational complexity.

Under these conditions, leaders might lack the visibility and bandwidth to lead digital innovation or a digital initiative with a sustainability focus.

H_3: Complexity negatively influences digital leadership in SMEs.

2.1.4. Ambiguity Negatively Influences Digital Leadership

Ambiguity is a phenomenon where there is an incompleteness of information, conflicting information, or information that can be interpreted in various ways, and thus leaders find it hard to recognize emerging trends or to find the right kind of strategic response [7]. Ambiguity is particularly common in digital transformation, whereby technologies change fast, sustainability standards evolve, and best practices are not yet determined. In situations of uncertainty, digital leaders might be unclear about the digital tools to use, the measurement of sustainability progress, and the future effects of new technology [24]. The lack of certainty enhances indecision, procrastination, and the lack of confidence among leaders to lead digital initiatives [25]. This research clarifies that ambiguity is a major factor that discredits digital leadership since leaders cannot read signals, deliver guidance, or motivate organizational commitment towards digital change.

The lack of clarity also causes misunderstandings among staff, which again reduces the ability to transform digital transformation initiatives based on leadership.

H_4: Ambiguity negatively influences digital leadership in SMEs.

2.1.5. Digital Leadership Positively Influences Sustainable Performance

Digital leadership has become one of the core drivers of sustainable performance, especially in SMEs that are exposed to high levels of digital and environmental pressure [26]. Digital leaders combine technology wise with strategy vision that helps firms to accept cutting-edge tools, re-design processes, and innovate sustainably [10]. Using data-driven decisions, digital leaders can improve operational efficiency, reduce waste, maximize resource utilization, and increase process visibility, leading to environmental and social sustainability outcomes [12]. Furthermore, digital leaders encourage lifelong learning, experimentation, and digital preparedness, establishing an organizational environment that fosters innovation related to sustainability [27]. Digital leadership is essential in SMEs with limited financial and human resources to align digital capabilities with long-term sustainability objectives. Leaders who believe in digital transformation enable the implementation of eco-efficient systems such as automation, analytics, IoT, and digital reporting tools that enhance accountability and ecological responsibility [12]. This research empirically confirms that digital leadership significantly contributes to sustainable performance by helping SMEs overcome digital challenges and strengthen operational performance while integrating sustainability into core strategic operations.

Therefore, digital leadership can be described as a dynamic capability that enables SMEs to attain economic, environmental, and social value in competitive environments.

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H_5: Digital leadership positively influences sustainable performance in SMEs.

2.1.6. Digital Organizational Culture Positively Moderates the Digital Leadership–Sustainable Performance Relationship

Digital organizational culture is a set of values, norms, and behaviors that encourage the adoption, utilization, and inculcation of digital technologies in an organization [13]. The success of leaders with effective digital competencies largely depends on the organization's readiness for a culture of change, even when their leaders possess high digital skills [28]. A digitally enabling culture makes employees more willing to use new tools, facilitates cross-functional collaboration, and promotes experimentation, contributing to the implementation of sustainability initiatives led by top management [29]. Digital culture in SMEs reduces resistance to change, develops digital literacy, and accelerates the adoption of digital solutions aimed at sustainability, such as automation, digital monitoring, and environmental analytics [30]. As shown in this research, digital organizational culture significantly enhances the correlation between digital leadership and sustainable performance, indicating that it is more effective when leadership can convert digital efforts into sustainability outcomes within an organizational culture that promotes technological openness and innovation.

When the environment of high digital culture, employees are more predisposed to leadership objectives, more active in working with digital tools, and more able to contribute to the long-term sustainability process. Conversely, weak digital cultures reduce leadership impact.

H_6: Digital organizational culture positively moderates the relationship between digital leadership and sustainable performance.

3. Methodology

3.1. Research Design

The research design used in this study is quantitative, explanatory research because it aims to discuss the effect of external VUCA factors (volatility, uncertainty, complexity, and ambiguity) on digital leadership and determine the effects of digital leadership on sustainable performance in SMEs. The research model is relational and predictive; thus, a cross-sectional survey was employed to gather primary data, which was done among SME managers. The design is suitable because it is used to test hypotheses and determine causal relations between latent constructs, particularly in dynamic digital settings [31]. The investigation has a positivist paradigm, which focuses on objective measurement, statistical analysis, and hypothesis testing, being based on a theory, as the thesis framework does.

3.2. Population and Sampling

The target group consisted of Qatari small and medium-sized enterprises (SMEs) in key sectors such as manufacturing, construction, telecommunications, and services, identified as priorities in Qatar's digital and sustainability agenda. SMEs were selected based on the Qatar Development Bank classification (QDB), which considers the number of employees and annual turnover. The purposive sampling method was used to select respondents with managerial or supervisory roles, as these individuals possess sufficient knowledge of leadership practices, digital transformation, and organizational performance.

The 10-times rule and PLS-SEM power analysis were used to evaluate the minimum sample size requirement. Since the model has six predictors, 150 responses were needed to meet the minimum, though to enhance the statistical reliability, the research gathered more than 300 valid responses, which aligns with the sample used in your thesis.

3.3. Data Collection Procedures

The data was gathered with the help of a structured and self-administered online questionnaire, distributed via email and professional networks. The digital survey tool was used so as to have a faster access to the decision-makers and also enabling the respondents to answer the tool at their own time. The level of participation was voluntary, and the level of anonymity was observed to minimize social

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desirability. The survey remained open for eight weeks, with follow-ups to improve response rates. The methodology reflects steps successfully used in your thesis, as it is accessible and cost-effective in SME settings.

3.4. Measurement of Variables

Validated scales based on previous literature were used to measure all constructs, supported by the results of your thesis measurement model.

The evaluation of items was performed based on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree).

- Volatility, Uncertainty, Complexity, and Ambiguity (VUCA): Bennett and Lemoine [1] scales were modified.
- Digital Leadership: Items were modified based on Westerman et al. [32] and measured using these items.
- Sustainable Performance: Products by El Baz and Iddik [33] and Tsvetkova, et al. [11], which will include items related to economic, environmental, and social aspects.
- Digital Organizational Culture (Moderator): Accommodated items of Warner and Wäger [34].

Everything showed satisfactory reliability (Alpha greater than 0.7) and validity in the thesis and was therefore appropriate to repeat in the present study.

3.5. Data Screening and Preparation

The data screening and preparation step involves organizing the data and analyzing it. <|human|>3.5 Data Screening and Preparation The data screening and preparation step entails sorting out data and analyzing it.

Data were screened before analysis for outliers, missing data, and normality. Mean substitution of missing values less than 5 percent was performed. Mahalanobis distance was used to examine outliers, and they were eliminated if necessary. Skewness and kurtosis values indicated the data were not normal, making PLS-SEM suitable due to its compatibility with non-normal data. These processes are similar to the data preparation steps used in your dissertation.

3.6. Data Analysis Technique

The analysis was conducted on the data using Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS 4.0, suitable for predictive research models and non-normal data. The analysis was performed in two stages. Measurement: First, Cronbach's Alpha, Composite Reliability, and AVE measures were used to assess the reliability and convergent validity of the measurement model, followed by HTMT to evaluate discriminant validity. Second, bootstrapping with 5,000 resamples tested path coefficients, significance levels, and effect sizes in the structural model. R2 and Q2 values were used to assess predictive accuracy and relevance. Moderation effects were examined using an interaction term.

3.7. Ethical Considerations

Prior to taking part, the information on the purpose of the study, confidentiality assurance, and the respondents' consent was provided. There were no personal identifiers gathered.

4. Findings and Analysis

4.1. Assessment of Measurement Model

The analysis of the measurement model was conducted to test the reliability and validity of all the latent constructs used in the study. The findings indicate good internal consistency, convergent validity, and indicator reliability across all constructs. The Alpha of the Cronbach was analyzed to be between 0.921 and 0.956, which was above the acceptable 0.70 and this showed that the items under each construct consistently measured the same concept underlying. Additionally, Composite Reliability (CR)

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coefficients were notably high, ranging from 0.943 to 0.964, confirming that the constructs had strong internal consistency and that measurements were free of errors.

The Average Variance Extracted (AVE) was used to measure convergent validity, with values ranging from 0.768 to 0.808. Since all AVE values were significantly above the minimum required level of 0.50, this indicates that each construct explained a significant share of variance through its indicators. The indicator loadings also support convergent validity, as all factor loadings fall within 0.844 to 0.916, well above the suggested lower limit of 0.70. This demonstrates that both items contributed highly to their respective constructs and were theoretically sound.

All constructs of the four dimensions of VUCA, Volatility, Uncertainty, Complexity, and Ambiguity, had high reliability and high indicator loadings, indicating that the VUCA scale is statistically strong in assessing external environment turbulence. Digital Leadership and Digital Organizational Culture also demonstrated good psychometric properties, with 7 and 4 items, respectively, loading over 0.87, confirming their theoretical relevance and consistency. Sustainable Performance, with 7 items, showed high reliability ($\alpha = 0.953$; CR = 0.961) and high loadings, suggesting it is a suitable multidimensional outcome variable.

In general, the results of the measurement model indicate that constructs are reliable, valid, and suitable for testing the structural model. The quality measurement indicators provide a solid foundation for examining the relationships between VUCA factors, digital leadership, digital culture, and sustainable performance.

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Table 1.
Reliability and validity.

Construct	Loading	Alpha	CR	AVE
AMBIGUITY		0.925	0.943	0.768
A1	0.873			
A2	0.844			
A3	0.895			
A4	0.870			
A5	0.897			
COMPLEXITY		0.932	0.949	0.787
C1	0.881			
C2	0.887			
C3	0.892			
C4	0.878			
C5	0.897			
DIGITAL LEADERSHIP		0.956	0.964	0.792
DL1	0.870			
DL2	0.897			
DL3	0.903			
DL4	0.880			
DL5	0.893			
DL6	0.894			
DL7	0.891			
DIGITAL ORGANIZATIONAL CULTURE		0.921	0.944	0.808
DOC1	0.889			
DOC2	0.916			
DOC3	0.900			
DOC4	0.891			
SUSTAINABLE PERFORMANCE		0.953	0.961	0.778
SP1	0.869			
SP2	0.889			
SP3	0.881			
SP4	0.875			
SP5	0.871			
SP6	0.901			
SP7	0.889			
UNCERTAINITY		0.935	0.950	0.792
U1	0.877			
U2	0.891			
U3	0.902			
U4	0.907			
U5	0.873			
VOLATILITY		0.935	0.951	0.794
V1	0.886			
V2	0.893			
V3	0.888			
V4	0.901			
V5	0.889			

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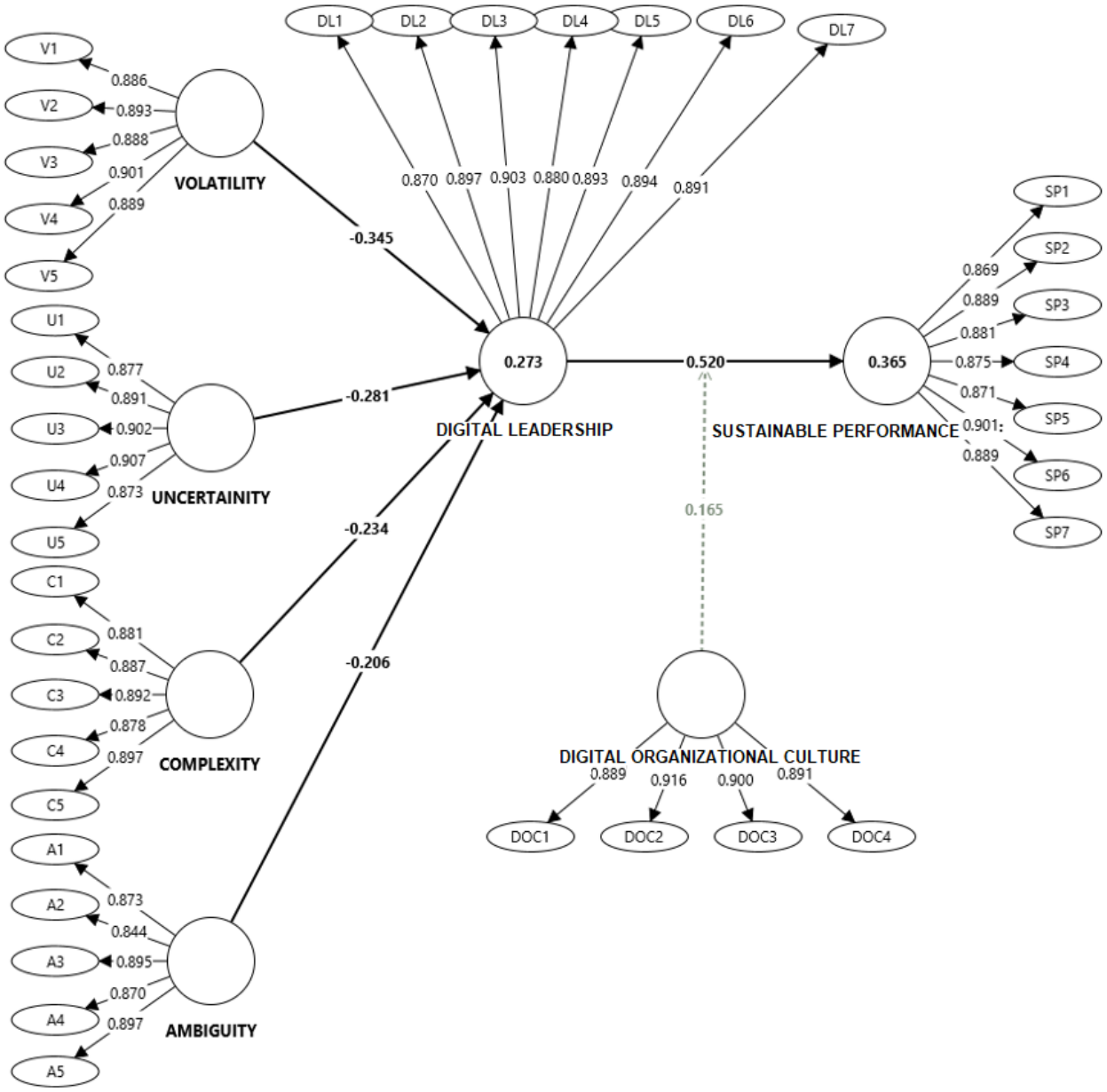

Figure 1.
Measurement Model.

4.2. Discriminant Validity

The HTMT criterion, identified as the most reliable tool for detecting construct overlap in PLS-SEM, was used to measure discriminant validity [35]. All HTMT values within the model are significantly below the conservative threshold of 0.85, indicating good discriminant validity [31]. The highest HTMT value is between Digital Leadership (DL) and Sustainable Performance (SP), at 0.555, well below the accepted limit, aligning with the theoretical expectation that DL is related to but distinct from SP. The VUCA dimensions (volatility, uncertainty, complexity, ambiguity) show low HTMT values with DL and SP, supporting the empirical distinctness of external turbulence constructs compared to leadership and performance measures [15]. Similarly, Digital Organizational Culture

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(DOC) exhibits small HTMT ratios (0.102–0.306), reinforcing its role as a moderating construct. Overall, the HTMT results confirm the absence of multicollinearity issues, with all constructs demonstrating satisfactory discriminant validity levels.

Table 2.
HTMT Criteria.

Construct	A	C	DL	DOC	SP	U	V
A							
C	0.038						
DL	0.182	.218					
DOC	0.088	0.085	0.102				
SP	0.113	0.153	0.555	0.306			
U	0.053	0.083	0.305	0.036	0.201		
V	0.073	0.133	0.323	0.030	0.216	0.038	

4.3. Assessment of Structural Model

The results of the structural model indicate that all the hypothesized relationships are statistically significant, showing good predictive validity. All the VUCA dimensions, including ambiguity, are significant ($b = -0.206$, $p < 0.001$), complexity ($b = -0.234$, $p < 0.001$), uncertainty ($b = -0.281$, $p < 0.001$), and volatility ($b = -0.345$, $p < 0.001$), have a strong negative impact on digital leadership. This aligns with previous studies suggesting that turbulent external environments hinder leaders' ability to successfully implement digital change [6, 15]. Digital leadership ($b = 0.520$, $p < 0.001$) strongly predicts sustainable performance, enhancing innovation, efficiency, and sustainability outcomes [10]. The positive impact of digital organizational culture on sustainable performance ($b = 0.234$, $p < 0.001$) is also significant, aligning with previous findings that supportive organizational cultures accelerate digital adoption [13]. The moderation effect is also high ($b = 0.165$, $p < 0.001$), which means that digital culture reinforces the role of digital leadership on sustainability, which promotes modern SEM suggestions to test interactions [31].

Table 3.
Path coefficients of hypothesized relationships.

Relationship	Beta	SD	t value	p value	Decision
A→DL	-0.206	0.045	4.603	0.000	Accepted
C→DL	-0.234	0.041	5.652	0.000	Accepted
DL→SP	0.520	0.038	13.871	0.000	Accepted
DOC→SP	0.234	0.043	5.431	0.000	Accepted
U→DL	-0.281	0.042	6.655	0.000	Accepted
V→DL	-0.345	0.041	8.360	0.000	Accepted
DOC*DL→SP	0.165	0.038	4.301	0.000	Accepted

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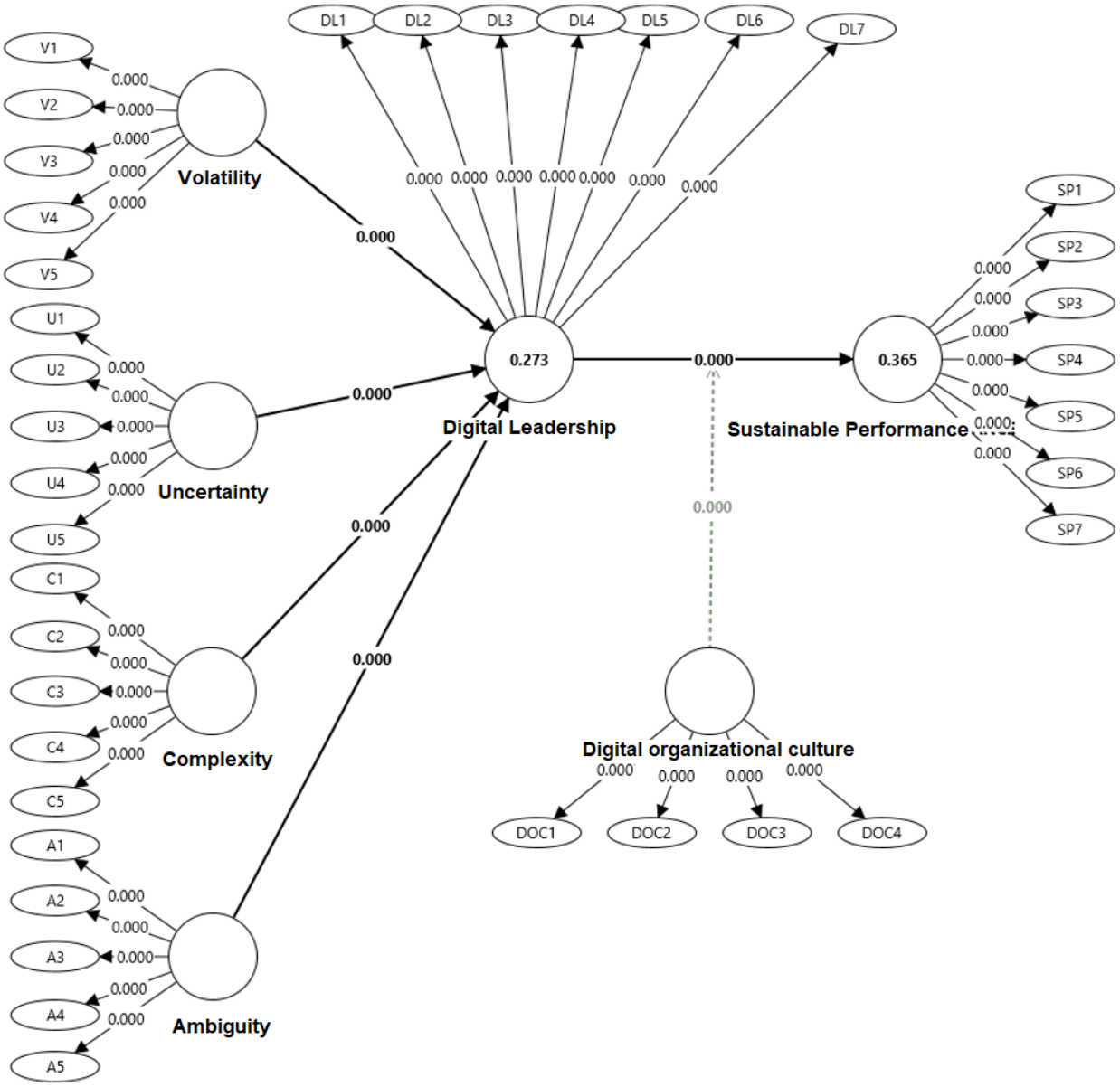

Figure 3.
Structural model.
(p-values 0.000)

4.4. Assessment of R- Square Value

The values of R-Squared represent the explanatory strength of the model. The R^2 of Digital Leadership is 0.273, which implies that ambiguity, complexity, uncertainty, and volatility explain these factors, respectively, 27.3 percent of the variance in digital leadership. Hair et al. [31] indicate that this is a moderate amount of explanatory power for behavioral research. The R^2 of Sustainable Performance is 0.365, meaning that the variance in performance can be explained by digital leadership, digital organizational culture, and the interaction term. This is acceptable and meaningful for the study of organizations, showing that the model is significantly predictive regarding sustainability outcomes in SMEs.

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Table 4.
R Square.

Variable	R Square	Adjusted R Square
Digital Leadership	0.273	0.266
Sustainable Performance	0.365	0.360

4.5. Assessment of Effect Size

The values of the effect size (f^2) represent the strength of each predictor on endogenous constructs. According to Hair et al. [31], values of 0.02, 0.15, and 0.35 indicate small, medium, and large effects. Digital leadership is most influenced by volatility ($f^2 = 0.161$, a medium effect), followed by uncertainty (0.108, small-to-medium) and complexity (0.074, small-to-medium). The effect of ambiguity is small (0.058). To achieve sustainable performance, digital leadership has the greatest impact (0.420), highlighting its central role [10]. Small but significant impacts are observed on digital organizational culture (0.085) and the moderation term (0.041).

Table 5.
Effect size (f^2).

Variable	Effect Size
A→ DL	0.058
C→DL	0.074
DL→SP	0.420
DOC→SP	0.085
U→DL	0.108
V→DL	0.161
DOC*DL→SP	0.041

4.6. Assessment of Predictive Relevance (Q^2)

The predictive relevance was measured using the cross-validated redundancy Q2 of the model obtained through blindfolding. Hair et al. [31] state that a Q2 value smaller than 0 indicates the model is not relevant for predicting a specific endogenous construct. The findings show Q2 = 0.214 for Digital Leadership and Q2 = 0.281 for Sustainable Performance, both above zero. These values suggest that the exogenous variables provide useful predictive value for the endogenous constructs, and the structural model can accurately reproduce observed data. Specifically, for sustainable performance, the predictive relevance is moderate and aligns with theory.

Table 6.
Cross-validated redundancy measure (Q^2), blindfolding direct relationship.

Variable	SSO	SSE	Q2= 1-(SSE/SSO)
Digital leadership	2625.000	2064.394	0.214
Sustainable performance	2625.000	1887.918	0.281

5. Discussion

5.1. H_1: Volatility→Digital Leadership

The results reveal that volatility negatively influences digital leadership significantly, implying that volatility limits leaders' ability to remain digitally focused and strategically oriented due to sudden and unstable external developments. This aligns with earlier VUCA literature, which suggests that volatile environments interfere with planning processes, promote reactionary decision-making, and reduce leaders' capacity to advance long-term technological projects [15]. The unpredictability of the environments around SMEs (changing market trends and satisfying consumer demands, fast policy shifts, and so forth) makes leaders focus on the short run, emphasizing survival over the long-term digital transformation. This limits the readiness of leaders to invest in digital tools or seek change oriented towards innovation. The negative value of the coefficient proves that when the external

circumstances vary frequently, leaders find it difficult to remain in the same direction digitally. Such outcomes can be corroborated with previous research that volatile environment undermines digital preparedness and strategic participation in digital [4]. Therefore, volatility is a structural hindrance that compromises the efficacy of executing the digital strategies by leaders.

5.2. H_2: The Uncertainty→Digital Leadership.

The influential adverse impact of uncertainty on digital leadership implies that the inability to predict the outcomes of the external environment weakens leaders' decision-making ability and decreases the uptake of digital initiatives. This aligns with earlier studies showing that uncertainty undermines leaders' skills in making projections, resource allocation, and assessing digital risks [5]. During unstable situations, SME leaders tend to be more conservative and risk-averse, postponing or reducing efforts in digital implementation. They may lack clarity regarding emerging technologies, regulatory performance, or market orientation, making long-term digital decisions difficult. These findings are consistent with the work of Alzoraiki et al. [19], who state that uncertainty limits the strategic flexibility and digital responsiveness of leaders. Since digital transformation requires focus and long-term dedication, uncertainty interferes with leadership continuity and team orientation. The findings highlight that uncertainty is not only an influencer of operational planning but also a drain on leaders' psychological confidence to champion digital transformation. Therefore, uncertainty is a decisive deterrent to successful digital leadership in changing environments.

5.3. H_3: Complexity→Digital Leadership

The adverse interaction between complexity and digital leadership highlights that multifaceted and interrelated external conditions overwhelm SME leaders and limit their digital strategic abilities. Complexity arises when leaders must respond to numerous variables simultaneously: technological convergence, regulatory requirements, customer expectations, and operational interdependencies. This aligns with González-Varona et al. [6], who suggest that complexity causes cognitive overload, reducing leaders' capacity to process information efficiently. Resource constraints in SMEs intensify this pressure, preventing leaders from prioritizing digital transformation or leading cross-functional digital initiatives. The findings also reflect the challenges leaders face when managing emerging technologies that demand specialized knowledge, integrated systems, and multidisciplinary decision-making [36]. As complexity increases, leaders may focus on operational chaos rather than driving digital innovation. The negative relationship is statistically significant, demonstrating that complexity undermines leadership coherence, strategic communication, and team direction. Therefore, the structural constraint is complexity, which diminishes leaders' digital performance.

5.4. H_4: Ambiguity→Digital Leadership

The drastic adverse impact that ambiguity has on digital leadership proves the fact that ambiguous, contradictory, or incomplete information weakens the capacity of leaders to facilitate digital transformation. The ambiguity causes leaders to struggle in the interpretation of the rising digital trends, assessing the sustainability-related technologies, or forecasting the effects of new innovations, in agreement with the findings [7]. According to SMEs, ambiguity causes reluctance and indecisiveness in decision-making because leaders are not very sure about choosing the right digital tools or developing digital strategies that would help them stay relevant in the future. This result is consistent with the general VUCA literature, claiming that ambiguity is an obstacle to the clarity of strategic vision and alignment in the organization [15]. In cases where leaders are not able to discern the environment, they are not able to inspire employees or make sense of making digital investments. The findings affirm that ambiguity enhances perceived risks, slows the adoption of digital technology, and decreases the capacity of leaders to paint a persuasive digital vision. Hence, ambiguity is a significant limiting factor to digital leadership in ambiguous markets.

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5.5. H_5 Digital Leadership→Sustainable Performance

The significant positive correlation between digital leadership and sustainable performance proves the fact that leaders who embrace the idea of digital technologies in their strategy improve the economic, environmental, and social performances of SMEs. The digital leaders help to automate processes, make decisions based on data, and adopt environmentally conscious practices, which will help to achieve sustainability goals [12]. The findings corroborate previous studies that state digital leadership is a driver of innovation, operational effectiveness, and responsible resource use [10]. In SMEs, where limited resources are usually the norm, digital leadership is effective in making the best use of digital tools to enhance productivity, eliminate waste, and improve environmental compliance. The high beta value shows that digital leadership is a core capability for attaining sustainable performance, which confirms the assumptions of the Resource-Based View (RBV), where digital capabilities are strategic assets. These results indicate that digital leadership does more than just increase competitiveness; it also promotes long-term sustainability by embedding digital thinking throughout the organization.

5.6. H_6 Moderating Role of Digital Organizational Culture

The high moderating impact of digital organizational culture indicates that a positive effect of digital leadership on sustainable performance is enhanced when the organization has a supportive digital culture. This aligns with the findings of Gerçek and Özveren [13], which state that digital culture boosts innovation, collaboration, and openness to technological change. A robust digital culture allows employees to embrace new technologies more easily, facilitates experimentation, and decreases resistance to digital transformation. The findings demonstrate that culture is a facilitating force that transforms leadership intentions into tangible sustainability results. When digital leadership is conducted within a favorable culture, sustainable performance is improved by enhancing team collaboration, digital capacity, and employee involvement in sustainability programs. Conversely, poor digital culture diminishes leadership performance and slows the pace of transformation. The results also support the importance of developing a digitally oriented culture to expand leadership influence, especially under conditions of rapid VUCA shifts.

6. Implications

6.1. Theoretical Implications

The research contributes to theory in several ways. First, it extends VUCA literature by empirically demonstrating that all four dimensions, volatility, uncertainty, complexity, and ambiguity, are significant impediments to digital leadership in SMEs. This supports placing digital transformation within the context of environmental turbulence. Second, the findings support the Resource-Based View (RBV) as they indicate that digital leadership is a strategic resource that contributes to sustainable performance. Digital competencies are considered as being strategic assets which allow firms to generate economic, environmental, and social value. Third, moderating influence of digital organizational culture contributes to the Contingency Theory, in that, cultural support enhances leadership performance in dynamic situations. This underscores that the success of digital transformation depends not only on leadership abilities but also on contextual cultural factors. Overall, these findings integrate VUCA theory, RBV, and digital culture literature into a unified framework, contributing to the theoretical understanding of sustainability-driven digital leadership.

6.2. Practical Implications

The results of this study would provide some practical information to SMEs who intend to enhance the results of digital transformation and sustainability. To start with, managers ought to design formal online training to improve leadership skills in digital strategy, analytics, and new technology. This is necessary since the impact of digital leadership on sustainable performance is the most significant. Second, agile planning and decision-making based on scenarios should be implemented in SMEs to

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survive in VUCA conditions. Leaders can use tools, including real-time dashboards, risk-mapping systems, and digital forecasting, to better react to volatility, uncertainty, complexity, and ambiguity. Third, it is proposed that the importance of digital organizational culture requires companies to undertake the active process of employee digital preparedness. The following are practical measures such as promoting digital experimentation, performing innovation, and incorporating digital tools into routine work processes. Fourth, SMEs must consider sustainability in digital innovation through technologies like automation, Internet of Things, and digital monitoring systems that will minimize waste and enhance efficiency. Lastly, there should be specific programs created by policymakers and SME support institutions, which would equip digital leadership capacity and foster digital culture, allowing SMEs to realize sustainable performance over the long term and in a changing environment.

6.3. Managerial Implications

The results offer valuable lessons for SME managers operating in VUCA settings. Firstly, leaders should willingly equip themselves to handle volatility, uncertainty, complexity, and ambiguity, as these external forces significantly diminish digital leadership efficiency. To mitigate the disruptive effects of VUCA conditions, managers are expected to invest in ongoing scanning of market trends, regulatory changes, and technological developments to lessen their impact. Secondly, the strong influence of digital leadership on sustainable performance indicates that SMEs need to focus on leadership development programs related to digital strategy, data-driven decision-making, and innovation management. This involves educating managers on online technologies, analytics, and agile leadership. Thirdly, managers should reinforce the digital organizational culture within the firm, as it increases employees' willingness to adopt digital solutions and enhances leadership's influence on sustainable performance. Promoting teamwork, experimentation, and openness to new technologies can significantly accelerate the progress of digital sustainability programs. Finally, SMEs should integrate digital transformation with sustainability objectives to ensure long-term competence and resilience.

6.4. Limitations and Future Research

This work has several limitations despite its contributions, which present opportunities for future research. Firstly, the study employed a cross-sectional design, limiting the ability to document whether digital leadership and sustainability change over time. Future research could adopt a longitudinal approach to track the dynamic development of the VUCA environment and digital transformation, as well as their impact on leadership behavior. Second, the research targeted SMEs in the Qatari context, which can be a limitation to generalizing the research to other countries where the regulatory, cultural, and technological landscape are different. The comparative analysis between developing and developed economies may shed more light on the external condition and provide information on how digital leadership is built across the world.

Third, self-reported surveys, a possible source of common method bias, were used to collect data. Multi-source data, including objective performance metrics, digital maturity measurements, or employee-level responses, can be included in future studies to enhance validity. Fourth, the model focused on a single moderating variable, which is digital organizational culture. Other mediators, such as technological readiness, environmental uncertainty, organizational structure, or innovation orientation, might also help shed more light on the boundary conditions of digital leadership effectiveness. Finally, mediating factors that could be investigated in the future include digital innovation capability, knowledge management practices, or employee digital engagement to reveal more profound pathways between leadership and sustainability.

7. Conclusion

This paper discusses the impact of external VUCA variables on digital leadership and the effect of digital leadership on sustainable performance in SMEs. The findings show that volatility, uncertainty, complexity, and ambiguity adversely affect the concept of digital leadership, illustrating the difficulties

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leaders face in turbulent environments. Nonetheless, robust digital leadership is known to promote sustainable performance significantly, making it central to digital transformation and sustainability progress. Moreover, digital corporate culture reinforces this relationship, demonstrating that cultural preparedness is key to leadership optimization. Overall, the research can be valuable to both theory and practice by showing how SMEs can become more resilient, digital, and focused on maintaining sustainability despite working in unpredictable, fast-changing contexts. This model can be extended to other sectors in future studies, allowing comparisons between developing and developed economies.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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