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Building Digital-Ready Leaders: Development and Validation of the Human-Centric Digital Leadership Scale

Haroon Abbu [1,*], Sarah Khan [1], Paul Mugge [1] and Gerhard Gudergan [2]

[1] Poole College of Management, North Carolina State University, Raleigh, NC 27695, USA; sskhan@ncsu.edu (S.K.)
[2] FIR e. V. an der RWTH, 52074 Aachen, Germany
* Correspondence: habbu@ncsu.edu

Abstract: The success of digital transformation initiatives relies heavily on effective digital leadership, which requires a blend of human-centric traits and technical expertise. While digital technologies enable transformation, organizations must develop leaders with the skills to navigate the complexities of change, foster innovation, and align strategies with organizational goals. Despite the growing importance of digital leadership, there is a lack of standardized, validated tools to measure and assess digital leadership competencies systematically. This study introduces the Digital Leadership Scale (DLS), a validated self-assessment tool designed to measure a leader's ability across seven human-centric dimensions essential for digital transformation: Positive Attitude, Ethical AI Use, Growth Mindset, Track Record, Transparent Agenda, Skills Acquisition, and Participative Style. The DLS serves as a practical tool for leaders to engage in self-reflection, identify strengths and development areas, and adopt personalized learning strategies. Organizations can leverage this scale to cultivate a digitally proficient workforce and foster leadership capabilities aligned with digital transformation success.

Keywords: digital leadership; self-assessment; leadership development; digital transformation; organizational change

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Academic Editor: David J. Edwards

Received: 10 February 2025
Revised: 25 February 2025
Accepted: 4 March 2025
Published: 11 March 2025

Citation: Abbu, H.; Khan, S.; Mugge, P.; Gudergan, G. Building Digital-Ready Leaders: Development and Validation of the Human-Centric Digital Leadership Scale. *Digital* **2025**, *5*, 7. https://doi.org/10.3390/digital5010007

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1. Introduction

Digital transformation is a people-centric process rather than a purely technological one. While technology acts as an enabler, organizational change depends on leadership, culture, and human adaptability. Successful digital transformation requires leaders who can navigate complexity, foster innovation, and drive strategic change while focusing on people and organizational values [1]. However, leading digital transformation presents unique challenges, including disruptive technological shifts, cultural resistance, and strategic misalignment.

Research indicates that leaders in digitally mature companies distinguish themselves by effectively aligning resources with strategic goals, fostering collaborative and agile work environments, and promoting open, transparent communication [2]. Their attributes and actions set digitally advanced organizations apart from those still developing [3–6].

Despite the increasing focus on digital leadership, there remains a lack of standardized, validated tools to measure and assess digital leadership competencies systematically. Leadership assessment has traditionally been based on technical expertise, management efficiency, or subjective evaluations, often overlooking human-centric traits essential for leading digital transformation. Thus, there is a critical need to develop and validate a

scale that identifies and measures the key leadership traits necessary for digital transformation success.

The primary objective of this paper is to develop and validate the human-centric Digital Leadership Scale (DLS) to help cultivate digital-ready leaders. To achieve this, this study explores three key research questions:

1. What are the essential traits and skills that define effective digital leadership?
2. How can these traits be systematically measured through a validated assessment tool?
3. How does the Digital Leadership Scale (DLS) contribute to leadership development and organizational transformation?

Using a rigorous statistical approach, we validate seven key dimensions of Digital Leadership—Positive Attitude, Ethical Use of AI, Growth Mindset, Track Record, Transparent Agenda, Skills Acquisition, and Participative Style—and outline actionable strategies for their development. The DLS integrates critical human-centric leadership dimensions, providing organizations with a practical framework to assess and develop digital leadership capabilities. This scale serves as a strategic tool for organizations to identify high-potential digital leaders, design targeted leadership development programs, and enhance digital transformation readiness.

The remainder of this paper is structured as follows: Section 2 presents a literature review on digital leadership, leadership assessment, and the challenges of leading in the digital age. Section 3 outlines the methodology, including scale development and validation. Section 4 presents the results of the empirical validation of the DLS. Section 5 describes the seven validated dimensions of the DLS, while Sections 6–8 conclude with a discussion of the results of this research, its limitations, and future research directions.

2. Literature Review

Digital transformation necessitates a strategic, cultural, and organizational shift that requires strong digital leadership. While digital technologies drive transformation, it is the ability of leaders to align these technologies with business objectives and human capital that determines success [1,7,8]. Leadership in the digital era demands an agile and adaptable mindset that fosters innovation while ensuring stability and resilience. Digital leadership is an ethical and adaptive approach that encourages trust, collaboration, and the ability to thrive in a rapidly evolving digital environment [9]. Unlike traditional leadership models, digital leadership incorporates elements of authentic, transactional, and transformational leadership [10].

Leadership assessment has long been a critical component of organizational effectiveness. Previous research has primarily focused on evaluating managerial skills, operational efficiency, and strategic decision-making [11,12]. However, as leadership models have evolved, scholars have recognized the growing importance of human-centered traits such as a positive attitude, growth mindset, and ethical decision-making. This shift has emphasized the need for leadership assessment models that integrate both strategic and interpersonal competencies.

A key limitation in existing leadership assessment models is the overemphasis on technical skills and managerial capabilities, often at the expense of human-centric leadership traits. While prior research has identified critical success factors for digital leadership, there remains a lack of validated assessment tools that can systematically evaluate leadership effectiveness in digital transformation contexts. Many existing leadership models do not account for the complexities of digital disruption and the unique challenges associated with leading in a technology-driven environment [13]. Moreover, leadership evaluations are often subjective, relying on qualitative assessments rather than empirical measurement criteria [1].

To address these gaps, researchers have advocated for an integrated, practice-oriented scale that can effectively measure digital leadership competencies. Tigre et al. [14] suggest that digital leadership consists of two core dimensions: business-oriented leadership, which includes strategic decision-making and execution, and human-oriented leadership, which focuses on emotional intelligence, ethical leadership, and interpersonal collaboration. While technical expertise remains essential, effective digital leaders must prioritize trust, empowerment, and engagement over purely technological capabilities.

Given the lack of comprehensive and validated models for assessing digital leadership, this study aims to develop a structured, evidence-based scale to measure its key dimensions. This research builds upon multiple studies we have conducted since 2018 on the role of digital leadership in successful digital transformations. Over the past several years, we have extensively explored this topic through in-depth case analyses of digital transformation initiatives, interviews with successful digital leaders, and surveys examining various aspects of human-centric leadership. The present study represents the culmination of this research, introducing the Digital Leadership Scale (DLS) and presenting seven validated human dimensions of digital leadership.

This paper builds upon our previous research on the human dimensions of digital leadership [6], in which we conducted an empirical study to identify the human qualities that significantly influence digital leaders' effectiveness. As part of this initial phase (Phase 1), we developed a set of survey items designed to capture the essential dimensions of digital leadership. This research led to the identification of 15 human-centric dimensions of digital leadership. To establish continuity with the current study, we summarize the findings from the Phase 1 study in Table 1, presenting the definitions of the identified dimensions, along with their theoretical foundations in leadership literature [6]. The summary presented in Table 1 provides a bridge to the current study, wherein we administered a survey and validated the DLS.

Table 1. Digital leadership dimensions: definitions and key theoretical support.

#	Dimension	Working Definition	Theoretical Support	Reference
1	Honesty	An assessment of the leader's moral character that connotes positive and virtuous attributes such as integrity, truthfulness, and straightforwardness. Honesty also involves being trustworthy, loyal, fair, and sincere.	Rotter (1967)	[15]
			Russell & Stone (2002)	[16]
			Ashton & Lee (2009)	[17]
			Kouzes & Posner (2011)	[18]
			Satow (2012)	[19]
2	Humility	An assessment of the leader's modest view of their own importance—that is, their humbleness.	Ashton & Lee (2009)	[17]
			Davis et al. (2017)	[20]
			Neilsen & Marrone (2018)	[21]
3	Courage	An assessment of the leader's mental or moral strength to venture, persevere, and withstand	Woodard (2004)	[22]
			Sanders (1994)	[23]
			Russell & Stone (2002)	[16]
			Woodard & Pury (2007)	[24]

Table 1. *Cont.*

#	Dimension	Working Definition	Theoretical Support	Reference
4	Ethical AI	An assessment of a leader's ability to do everything in their power to ensure the results of AI and other technologies employing machine learning models, are fair and explainable.	DeBrusk (2018)	[25]
			Brown & Treviño (2006)	[26]
			Cortellazzo, Bruni, & Zampieri (2019)	[27]
5	Growth Mindset	An assessment of the leader's desire to tackle new challenges and grow as a person.	Dweck (2016)	[28]
			Gottfredson & Reina (2020)	[29]
			Carpenter (2012)	[30]
			Petrucci & Rivera (2018) Prince (2018)	[31]
6	Transparent Agenda	An assessment of a leader's ability to openly share information about the business strategy with employees, which is necessary for collaboration, cooperation, and collective decision-making.	Bernstein (2017)	[32]
			Wagner (2014)	[33]
			Tardieu et al. (2020)	[34]
7	Data Focus	An assessment of a leader's ability to encourage the application of data and analytics everywhere,	Weiner, Balijepally, & Tanniru (2015)	[35]
			Pratt & Fruhlinger (2019)	[36]
			Bisson, et al. (2018)	[37]
8	Inspire Engagement	An assessment of a leader's ability to stimulate people's interest in or enthusiasm for doing	Horner-Long & Schoenberg (2002)	[38]
			Kane et al. (2019)	[7]
			Witemeyer, Ellen, & Straub (2013)	[39]
9	Storytelling	An assessment of the leader to inspire employees and gain buy-in.	Merath & Nau (2017)	[40]
			Rossetti & Wall (2017)	[41]
			Taylor (2021)	[42]
10	Digital Literacy	An assessment of a leader's ability to develop digital competencies within the leadership team.	Kane et al. (2019)	[7]
			Cortellazzo, Bruni, & Zampieri (2019)	[27]
			Jin et al. (2020)	[43]
11	Positive Attitude	An assessment of a leader's ability to carry themselves like champions and purposefully show their positivity in how they behave and communicate.	Creusen, Eschemann, & Johann (2010)	[44]
			Liu, Siu, & Shi (2010)	[45]
12	Skills Acquisition	An assessment of a leader's ability to influence digital talent acquisition and development for	UNESCO (2018)	[46]
			Maurer (2019)	[47]
13	Knowledge Sharing	An assessment of a leader's ability to enable access to knowledge and improve learning.	Berman & Korsten (2014)	[48]
			Boe & Torgersen (2018)	[49]
14	Participative Style	An assessment of a leader's ability to develop a collaborative and inclusive way to approach	Schwarzmüller et al. (2018)	[50]
			Pentland (2018)	[51]
			Bhatti et al. (2019	[52]
15	Track Record	An assessment of the leader's digital	Prince (2018)	[10]

3. Materials and Methods

We employed a mixed-method approach to scale development, consistent with Churchill [53], encompassing the identification of dimensions and survey items, data collection, statistical analysis using factor analysis, reliability and validity assessment, and final scale refinement.

In this study, we administered a survey containing 15 dimensions and 45 items derived from Phase 1 (please refer to Appendix A for a list of the dimensions and items). Each item was measured using a five-point Likert scale, allowing for two agreement options, two disagreement options, and a neutral option. To enhance response quality and reduce bias, we also included a "no answer" option. Additionally, to ensure contextual analysis, we integrated contingency factors—such as region, gender, leadership span, and industry type—by placing these demographic questions at the beginning of the survey.

The survey was distributed to managers from various organizations between July 2021 and August 2024 using LimeSurvey, a widely recognized online survey platform for research institutions and universities. To ensure meaningful results, we selected participants with substantial leadership experience. The operationalized dimensions were neither explicitly named nor randomized but were presented in their original order, allowing respondents to recognize a logical progression [54].

A total of 202 usable responses were collected. Among the participants, 63.9% identified as male, 34.2% as female, and 2.0% as non-binary. Most respondents were from the United States (33.2%) and Germany (43.1%), while others represented Asia (5.0%), Australia (2.5%), the UK (0.5%), and other regions (15.8%). Most participants held leadership roles, with 81% leading their own teams. Team sizes varied, with 42.1% managing teams of 1–10 people, 25.7% overseeing 11–50 people, 9.4% leading 51–150 people, and 3.0% managing 151–500 individuals. Industry representation was balanced, with 48.0% of respondents being from the hardware sector and 52.0% from the software industry.

To identify key human dimensions of digital leadership and refine the scale, we conducted a Principal Component Analysis (PCA) using IBM SPSS Statistics v. 29. We applied Promax rotation with Kaiser Normalization, as Promax rotation allows correlation between the rotated components, facilitating a more meaningful interpretation of the extracted factors.

4. Results

The initial review of the scree plot revealed 11 extracted factors; however, multiple items exhibited cross-loadings and low factor loadings, necessitating further refinement. To determine the optimal factor structure, we considered the amount of variance explained, the interpretability of extracted factors, and the overall cleanness of the structure, ensuring that no items cross-loaded and that all factor loadings exceeded the 0.40 threshold [55].

A total of 24 items were removed from the initial item pool due to cross-loadings or inadequate factor loadings (below 0.40). These excluded items were associated with the dimensions of honesty, humility, courage, data focus, inspiring engagement, storytelling, digital literacy, and knowledge sharing. Following this refinement, seven components emerged based on the scree plot (Figure 1), eigenvalues, and a balance between parsimony and theoretical plausibility. The remaining 21 items demonstrated adequate factor loadings, and no items cross-loaded on multiple factors, confirming the structural integrity of the scale. Table 2 presents the factor loadings.

The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.78, exceeding the recommended minimum threshold of 0.50, confirming that the sample was suitable for factor analysis. Additionally, Bartlett's test of sphericity was statistically significant ($p < 0.01$), further indicating that the data were appropriate for factor extraction. The final seven-component model accounted for 75.27% of the total variance, with each component contributing as follows:

- Component 1 (31.64% variance): Three items related to the Positive Attitude dimension.
- Component 2 (12.69% variance): Three items associated with the Ethical AI dimension.
- Component 3 (7.82% variance): Three items related to the Growth Mindset dimension.

- Component 4 (6.79% variance): Three items corresponding to the Track Record dimension.
- Component 5 (6.32% variance): Three items linked to the Transparent Agenda dimension.
- Component 6 (5.10% variance): Three items associated with the Skills Acquisition dimension.
- Component 7 (4.88% variance): Three items reflecting the Participative Style dimension.

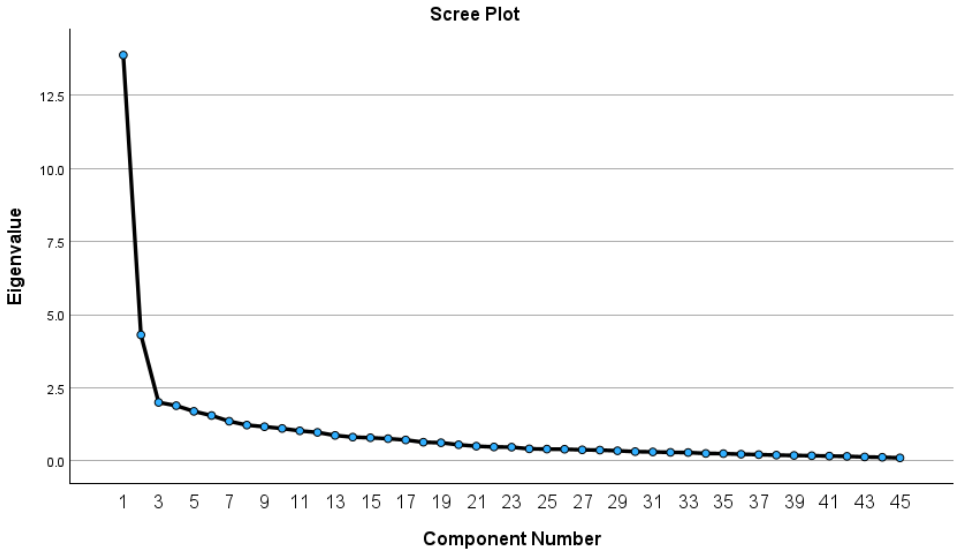

Figure 1. Scree plot of the final components.

Table 2. Loadings with principal component analysis.

	Positive Attitude	Ethical Use of AI	Growth Mindset	Track Record	Transparent Agenda	Skills Acquisition	Participative Style
PositiveAttitude_3	0.977						
PositiveAttitude_1	0.897						
PositiveAttitude_2	0.784						
EthicalAI_2		0.925					
EthicalAI_3		0.889					
EthicalAI_1		0.830					
GrowthMindset_2			0.903				
GrowthMindset_3			0.842				
GrowthMindset_1			0.814				
TrackRecord_2				0.915			
TrackRecord_3				0.901			
TrackRecord_1				0.685			
TransparentAgenda_2					0.872		
TransparentAgenda_3					0.813		
TransparentAgenda_1					0.803		
SkillsAcquisition_3						0.889	
SkillsAcquisition_1						0.86	

Table 2. *Cont.*

	Positive Attitude	Ethical Use of AI	Growth Mindset	Track Record	Transparent Agenda	Skills Acquisition	Participative Style
SkillsAcquisition_2						0.735	
ParticipativeStyle_2							0.893
ParticipativeStyle_1							0.804
ParticipativeStyle_3							0.449

As a result of this analysis, we finalized a seven-component Digital Leadership Scale (DLS) with 21 validated items (see Appendix B).

Scale Reliability and Validity

We evaluated the internal consistency reliability, convergent validity, and discriminant validity of the scale. Cronbach's alpha was used to assess the internal consistency of the items measuring each dimension (see Table 3). A recommended threshold for item loadings is above 0.7, as this indicates that the construct explains more than 50% of the variance in its respective indicators, thereby ensuring acceptable item reliability [56,57]. The Cronbach's alpha values exceeded the required threshold of 0.70, confirming the reliability of the measures.

Table 3. Assessment of reliability and convergent validity.

Construct	Number of Items	AVE	Composite Reliability	Cronbach's Alpha
Positive Attitude	3	0.79	0.92	0.861
Ethical use of AI	3	0.78	0.91	0.868
Growth Mindset	3	0.73	0.89	0.787
Track Record	3	0.71	0.88	0.819
Transparent Agenda	3	0.69	0.87	0.821
Skills Acquisition	3	0.69	0.87	0.8
Participative Style	3	0.55	0.77	0.713

To assess convergent validity, we examined the average variance extracted (AVE) and composite reliability (CR). According to Fornell and Larcker [58], the acceptable thresholds for AVE and CR are 0.5 and 0.7, respectively. All items met these criteria, establishing that the construct explains a substantial proportion of the variance in each indicator, thereby supporting acceptable convergent validity.

Discriminant validity was evaluated using the approach suggested by Chin [59], in which each construct should exhibit greater variance with its own indicators than with other constructs. As shown in Table 4, the square roots of the AVE values along the main diagonal were greater than the pairwise correlations between constructs on the off-diagonal. This result confirms that each dimension of the scale is empirically distinct and that the items have a higher loading on their respective dimension than on any adjacent dimension, thus supporting discriminant validity.

Table 4. Pairwise correlations: assessment of discriminant validity.

	Positive Attitude	Ethical Use of AI	Growth Mindset	Track Record	Transparent Agenda	Skills Acquisition	Participative Style
Positive Attitude	**0.890**						
Ethical Use of AI	0.139	**0.882**					
Growth Mindset	0.303	0.388	**0.854**				
Track Record	0.564	0.323	0.407	**0.840**			
Transparent Agenda	0.230	0.348	0.433	0.280	**0.830**		
Skills Acquisition	0.303	0.505	0.453	0.328	0.445	**0.831**	
Participative Style	0.504	0.283	0.324	0.615	0.261	0.279	**0.741**

5. Validated Dimensions of Digital Leadership Scale (DLS)

In this section, we describe the seven validated human dimensions of DLS and specify the types of actions that promote their fulfillment.

5.1. Dimension 1: Positive Attitude

Leaders who demonstrate a positive attitude exhibit greater resilience, social integration, and high performance [44]. A leader's optimistic mindset and constructive leadership style have been shown to enhance employee confidence, commitment, and overall well-being over the long term [45].

In the context of digital transformation, where uncertainty and risk are inherent, a positive attitude plays a critical role in instilling confidence within an organization. Digital leaders must champion organizational success, remain committed to strategic objectives, and advocate for the company's best interests despite challenges. Furthermore, they must be open to exploring emerging technologies and innovative ideas, exercising patience as they balance technological advancement with effective change management. Given these demands, a positive attitude is a fundamental trait of effective digital leadership.

5.2. Dimension 2: Ethical Use of AI

Recent advancements in machine learning, neural networks, and large language model-driven Generative AI have significantly expanded the use of artificial intelligence (AI) across various domains, including hiring, criminal justice, healthcare, product development, research, and content generation. As AI is integrated into businesses, concerns surrounding AI ethics and unintended algorithmic biases have become central to digital leadership.

Digital leaders must leverage the benefits of AI while proactively addressing its ethical, legal, and societal implications. They have a responsibility to ensure that AI-driven decisions are fair, transparent, and explainable, fostering trust in these technologies. Ethical AI use requires leaders to reflect on data-driven insights and critically evaluate cause-and-effect relationships while considering the broader context to avoid premature or erroneous decision-making [1]. Furthermore, digital leaders must advocate for trustworthy AI at the executive level, ensuring that senior management understands the importance of AI ethics. They should implement processes to minimize algorithmic bias and actively engage

in training and governance initiatives that promote ethical AI practices. By fostering a culture of responsible AI adoption, digital leaders play a critical role in ensuring that AI technologies are developed and deployed in ways that are both equitable and aligned with societal values.

5.3. Dimension 3: Growth Mindset

A growth mindset embodies the belief that intelligence, abilities, and skills can be developed through continuous learning, effort, and perseverance [28]. Leaders with a growth mindset are more adaptable to change, exhibit stronger problem-solving skills, and effectively respond to feedback [29]. Digital leaders proactively seek opportunities to innovate, embracing creative and sometimes high-risk strategies to drive organizational success [30]. Encouraging curiosity, alternative thinking, and a commitment to lifelong learning fosters an organizational culture that thrives in a rapidly evolving digital landscape [31].

For digital leaders, a growth mindset is essential for navigating technological disruptions and fostering a culture of trust, openness, and calculated risk-taking. By fostering a mindset that values learning over perfection, digital leaders can build innovative and resilient organizations, ensuring sustained success in an increasingly complex and fast-changing digital environment.

5.4. Dimension 4: Track Record

A track record serves as a transactional aspect of digital leadership, emphasizing a leader's personal accountability, credibility, and capacity for self-assessment. Digital leaders must continuously evaluate their competencies, adapt to emerging disruptions, and enhance their digital literacy to remain effective. Successful digital transformation is inherently results-driven, requiring leaders to demonstrate measurable outcomes, whether in efficiency gains, cost reductions, or enhanced customer experiences [10].

Credibility is the foundation of trust-based leadership, and leaders with a strong track record establish trust more quickly, leading to higher employee engagement and organizational commitment [60]. Employees are more likely to trust and follow a leader who has demonstrated tangible success in driving digital change—whether by improving business processes, reducing operational inefficiencies, or enhancing customer experiences through digital innovation. A proven ability to execute transformational initiatives reinforces confidence in leadership and fosters a culture of trust, innovation, and long-term success.

5.5. Dimension 5: Transparent Agenda

Transparency in leadership encompasses openness and the dissemination of clear and accurate messages [32]. Within the context of digital transformation, transparency is crucial in ensuring that employees are well informed about opportunities and risks, enabling them to make rational decisions and actively participate in the transformation process. Greater transparency fosters employee engagement and significantly reduces resistance to change, a decisive factor in the success of digital initiatives [33].

Transparent leadership is also a means of accountability, as employees must witness leaders "walking the talk"—demonstrating commitment to the initiatives they advocate [18]. Given the often uncharted nature of digital transformation, trust plays a pivotal role in navigating uncertainty. When leaders are open, vulnerable, and transparent, they create an environment of trust, leading to stronger teams, improved knowledge sharing, and better overall results [1]. Digital leaders must communicate all aspects of their digital strategy, ensure accessibility of information to all stakeholders, and clearly quantify the benefits of their digital initiatives to align organizational efforts.

5.6. Dimension 6: Skills Acquisition

Identifying, attracting, and retaining digital talent is a critical responsibility of digital leaders. In the connected economy, digital skills must be integrated with core competencies such as literacy, critical thinking, problem-solving, collaboration, and socio-emotional intelligence. Soft skills, including agility, creativity, teamwork, and adaptability, are essential for long-term employability in an increasingly automated world [47].

As many executives leading digital initiatives are not digital natives, they must embrace continuous learning and remain open to insights from others. Digital leaders must actively update their knowledge through formal education, in-house training, and online learning platforms [7]. Beyond personal learning, leaders should engage in digital talent acquisition, drive retraining efforts, and foster partnerships with universities and educational institutions to recruit digitally skilled professionals who can propel their organizations forward.

5.7. Dimension 7: Participative Style

Effective digital leadership is inherently collaborative, requiring leaders to actively involve their teams in decision-making and operational processes [50]. Leaders who engage in frequent and meaningful interactions, disseminate information equally, and ensure all team members have an opportunity to make a meaningful contribution are seen to exhibit a participative style of leadership [51].

A participative leadership style fosters resilient organizations that can swiftly respond to digital disruptions. By creating open spaces for collaboration, allowing employees to exercise autonomy in their contributions, and motivating voluntary engagement, digital leaders can build adaptable and high-performing teams [61]. Leaders must also celebrate both small and significant achievements, actively engage with development teams, and prioritize availability for employees, fostering an environment of inclusion, trust, and shared success.

6. Discussion and Impact on Leadership Development

The rapid acceleration of innovation and R&D is largely driven by digital technologies. While these technologies serve as enablers of transformation, they alone do not guarantee success. Digital transformations are inherently complex and require organizations to meet specific preconditions to navigate these uncharted waters effectively. Research underscores the urgent need for strong digital leadership in organizations. Link [62] found that only 37% of respondents in a Randstad North America study believed their organization had a strong digital leader in place. Similarly, Kane et al. [7] reported that 77% of respondents from large companies at the early stages of digital transformation acknowledged the need to identify and develop new leaders capable of guiding their organizations in the digital age.

Developing competent digital leaders is paramount to ensuring the success of digital transformation initiatives. However, there remains a gap in structured mechanisms for leaders to cultivate the skills necessary to build trust, a fundamental element in digital transformation. The Digital Leadership Scale (DLS) developed in this study provides organizations with a systematic approach to developing digital leadership as an organizational capability. By using the DLS, leaders can engage in self-reflection, enhance their ability to lead with trust, and improve their effectiveness in digital environments. The scale also serves as a self-assessment tool, facilitating an approach that fosters critical reflection, personal accountability, and autonomous learning [63]. Such formative self-assessment processes—whether tutor-led, peer-led, or self-guided—enable individuals to identify their strengths and weaknesses, empowering them to take responsibility for their growth and development. Learning and development initiatives can further support digital leaders

by reinforcing key competencies, including ethical AI use, a positive attitude, humility, transparency, skills acquisition, participative leadership, and a strong track record.

This study contributes significantly to the development of future digital leaders by offering a structured framework for identifying and addressing leadership gaps. Depending on an individual's leadership level and skill deficit, tailored developmental actions may be appropriate. For entry-level employees, this may include reading assignments or brief literature reviews to be shared within the organization. More senior employees may benefit from mentorship programs, rotational assignments, or executive education opportunities. At an organizational level, learning and development teams can implement "lunch and learn" sessions, online training modules, or the use of third-party e-learning platforms such as Coursera, LinkedIn Learning, or Udemy.

Digital transformation has also reshaped corporate training methods, with a shift toward microlearning, gamification, content personalization, and mobile-accessible training. These evolving approaches, coupled with remote learning capabilities, provide greater flexibility, increased engagement, and cost-effective skill development [64]. As corporate training continues to evolve, organizations must embrace innovative learning strategies that equip digital leaders with the competencies necessary to navigate an increasingly complex digital landscape.

7. Future Research and Limitations

Expanding the sample size will enhance the generalizability of the scale and provide deeper insights into digital leadership competencies across diverse organizational contexts. Additionally, we have developed a web-based, user-friendly self-assessment tool that allows leaders to measure the gap between their desired behaviors (e.g., Likert levels 4 or 5) and their current performance across the 21-item scale, spanning 7 dimensions. This tool will provide leaders with personalized insights into areas for growth, helping them identify opportunities for behavioral optimization.

The self-assessment tool is designed to encourage personal reflection and leadership development based on empirical research rather than external expectations. Alongside this tool, self-training aids can be developed to support digital leaders in acquiring critical competencies and bridging skill gaps. Future research should explore how digital-age leadership skills evolve over time, as well as how advancements in emerging technologies may necessitate new leadership dimensions. Researchers will also need to design the web-based tool and database to capture these evolving competencies, ensuring that digital leadership development remains dynamic and adaptive to technological advancements.

This study has certain limitations. While the dimensions of digital leadership are based on well-established theoretical constructs, further validation with a larger and more diverse sample is needed to enhance the reliability and applicability of the scale. The current dataset is limited to respondents from the United States and Germany, meaning cultural differences in these regions may have influenced the selection of key dimensions. Expanding the study to additional geographic regions would improve its generalizability and offer insights into the role of cultural factors in digital leadership.

Additionally, future research should target a broader range of industries, including non-profit organizations, which have traditionally been slower in adopting digital technologies. Longitudinal studies could also examine whether higher Digital Leadership Scale (DLS) scores correlate with organizational performance, providing a clearer link between digital leadership and business outcomes. Another promising avenue for future research is exploring how digital leadership can be effectively integrated into organizational strategies. Investigating how the Digital Leadership Scale (DLS) can inform strategic decision-making in areas such as recruitment, training, and succession planning would enhance the model's

practical applicability, providing organizations with a structured approach to developing and sustaining digital-ready leaders.

The large-scale, global deployment of the self-assessment tool and its supporting training resources will require collaborative efforts across industries, academic institutions, and research organizations. While the authors have conducted extensive interviews with leaders worldwide, expanding this initiative will require additional partnerships to facilitate wider implementation and adoption.

8. Conclusions

Transformations are inherently challenging, and digital transformations are even more complex, as they not only disrupt organizational processes and structures but also significantly impact behavior and culture. Given the widespread adoption of digital transformation initiatives, organizations require leaders with exceptional human-centric capabilities to navigate these changes effectively. This study presents a valid and reliable tool that enables digital leaders to assess their performance gaps across seven key human dimensions, all of which are critical for successful digital transformation.

The Digital Leadership Scale (DLS) is designed for self-assessment, providing leaders with an opportunity to reflect on their strengths and areas for improvement. Self-assessment fosters personal buy-in and increases commitment to professional development, as leaders take an active role in shaping their own improvement plans. To address skill gaps, leaders can select from a range of self-training options, including formal education programs, in-house training, and online learning platforms. Looking ahead, digital leaders must continuously update their knowledge and remain adaptable to emerging technologies. We believe that self-assessment tools and structured training resources, grounded in statistically validated measures, represent a significant step toward building the digital leadership capabilities necessary for transformation success.

Author Contributions: Conceptualization, H.A., P.M. and G.G.; methodology; H.A., P.M. and S.K.; software, S.K.; validation, S.K.; formal analysis, S.K.; investigation, H.A., S.K., P.M. and G.G.; resources, H.A., S.K., P.M. and G.G.; data curation, H.A., P.M. and S.K.; writing—original draft preparation, H.A., P.M. and S.K.; writing—review and editing, H.A., S.K., P.M. and G.G.; supervision, H.A. and P.M.; project administration, S.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding. The APC was funded by NC State University's Distance Education and Learning Technologies Application (DELTA).

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Forty-Five Items Used in Principal Component Analysis

Code	Sentence
As a leader of digital initiatives, I . . .	
Item_1	Address concerns employees have with the digital strategy publicly.
Item_2	Give employees clear answers, even to critical questions.
Item_3	Do my best to talk straight, and I expect the same from my employees.

Code	Sentence
Item_4	Respect the opinions of our employees, even if it is not the same as mine.
Item_5	Value every contribution of every individual, no matter how big or small it may be.
Item_6	Gratefully accept any feedback both positive and negative.
Item_7	Change the plan when presented with new, disruptive market realities.
Item_8	Do the right thing for our company even if this could have unpleasant consequences.
Item_9	Pursue the strategy even when I know it will be difficult to achieve.
Item_10	Make sure senior management understands the need for building trustworthy AI that ensures fairness and accuracy, which meets their privacy and compliance requirements.
Item_11	Put processes in place to ensure no human biases creep into algorithms and affect outcomes.
Item_12	Develop and encourage participation in training sessions related to ethics in AI.
Item_13	Don't view failure as a disappointment but as a learning experience that can lead to change.
Item_14	Believe that all people, including myself, can develop their capabilities to do new things, regardless of where they come from.
Item_15	Accept new challenges, take advantage of feedback, and provide timely feedback to subordinates.
Item_16	Never hide my intentions; I reveal all aspects of our digital strategy to the organization.
Item_17	Make sure the digital strategy is documented and accessible to all stakeholders.
Item_18	Ensure that the benefits of our digital strategy are quantifiable so that everyone clearly understands them.
Item_19	Use data analytics to drive our major operational and strategic decisions.
Item_20	Trust data more than my intuition.
Item_21	Make sure the right people in their organization have the training and skills necessary to work with data.
Item_22	Let people know that their input matters and that they have the autonomy to develop and implement new ideas.
Item_23	Create a sense of urgency, enthusiasm, and pride at work.
Item_24	Appreciate our willingness to expend the effort necessary to persist in the face of challenges.
Itrem_25	Use storytelling effectively to drive the purpose of our digital transformation journey (at shareholder meetings, to staff, and to the public).

Code	Sentence
Item_26	Continually reinforce our mission for digital transformation—my story—in daily happenings as much as possible.
Item_27	Encourage our employees to become storytellers and ambassadors of change themselves.
Item_28	Make sure that everyone on the direct report team has the necessary technical skills to implement our digital strategy.
Item_29	Regularly seek outside resources (advice of thought leaders, joint research projects, partnerships, executive education, etc.) to maintain the organization's digital talents.
Item_30	Ensure the entire leadership team knows the strategic and operational benefits of our digital technologies.
Item_31	Advocate consistently for the best interests of our company.
Item_32	Take it on myself to be accountable.
Item_33	Am committed to the success of our company.
Item_34	Am personally involved in our efforts to recruit digital talents to the organization.
Item_35	Influence efforts to retrain and rebalance the organization's digital skills.
Item_36	Have initiated active programs with local colleges and universities to recruit digitally talented people.
Item_37	Insist we share our knowledge, particularly with other departments/organizations struggling with digital transformation.
Item_38	Give every employee the opportunity to present "what they are learning/have learned" to the rest of the organization.
Item_39	Have implemented "safety nets" that encourage experimentation and exploration of the new knowledge.
Item_40	Require that we celebrate "small wins," as well as major accomplishments, to motivate employees.
Item_41	Prefer "rolling up my sleeves" and working directly with the development teams.
Item_42	Make time for people who have questions.
Item_43	Changed an aspect of business using digital methods.
Item_44	Reduced the cycle time or operational cost of the business significantly.
Item_45	Created an overall better customer experience.

Appendix B. Seven Dimensions and Twenty-One Items of Digital Leadership Scale

Dimension	Item	
#1 Positive Attitude	1.	Advocate consistently for the best interests of our company
	2.	Take it on myself to be accountable.
	3.	Am committed to the success of our company.
#2 Ethical Use of AI	4.	Make sure senior management understands the need for building trustworthy AI that ensures fairness and accuracy which meets their privacy and compliance requirements.
	5.	Put processes in place to ensure any human biases do not creep into algorithms and affect outcomes.
	6.	Develop and encourage participation in training sessions related to ethics in AI.
#3 Growth Mindset	7.	Don't view failure as a disappointment but as a learning Experience that can lead to change.
	8.	Believe that all people, including myself, can develop their capabilities to do new things, regardless of where they come from.
	9.	Accept new challenges, take advantage of feedback, and provide timely feedback to subordinates.
#4 Track Record	10.	Changed an aspect of business using digital methods.
	11.	Reduced the cycle time or operational cost of the business significantly.
	12.	Created an overall better customer experience.
#5 Transparent Agenda	13.	Never hide my intentions; I reveal all aspects of our digital strategy to the organization.
	14.	Make sure the digital strategy is documented and accessible to all stakeholders.
	15.	Ensure that the benefits of our digital strategy are quantifiable so that everyone clearly understands them.
#6 Skills Acquisition	16.	Am personally involved in our efforts to recruit digital talents to the organization.
	17.	Influence efforts to retrain and rebalance the organization's digital skills.
	18.	Have initiated active programs with local colleges and universities to recruit digitally talented people.

Dimension	Item	
#7 Participative Style	19.	Require that we celebrate "small wins," as well as major accomplishments, to motivate employees.
	20.	Prefer "rolling up my sleeves" and working directly with the development teams.
	21.	Make time for people who have questions.

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