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Development and validation of digital leadership skills scale

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ABSTRACT

Objective: The main aim of this study is to construct a digital leadership skills scale (DLS scale) to measure digital leadership skills. Moreover, by integrating the constructed scale into the existing model in the literature, we aimed to investigate the influence of the DLS scale on organisational factors, digital transformation, and enterprises' financial performance.

Research Design & Methods: We used the quantitative research method to construct the DLS scale and to test the proposed model based on a sample of 701 active employees in enterprises. In the first stage of the study, we conducted the comprehensive validity and reliability analysis including content validity, construct validity based on explanatory factor analysis, reliability analysis via Cronbach's alpha, Spearman-Brown coefficient, and retest reliability with Intraclass correlation and Pearson correlation coefficients, confirmatory factor analysis, and item analysis during the development process of the DLS scale. In the second stage, we integrated the digital leadership skills scale into the existing model as a factor and examined the overall compatibility and harmony of the integrated DLS scale items with the existing model. In the third stage of the study, we tested the proposed model with a linear regression analysis model.

Findings: The comprehensive validity and reliability analysis results showed that the constructed DLS scale is valid and reliable. Moreover, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), reliability, item analysis, convergent, and discriminant validity analysis results indicated that the constructed DLS scale was harmoniously integrated with the existing model in the literature. Moreover, simple linear regression analysis results indicated that the constructed digital leadership skills scale influences organisational factors, digital transformation (DT), and enterprises' financial performance.

Implications & Recommendations: With the constructed scale, it will be possible for enterprises undergoing digital transformation to measure their digital leadership skills. Moreover, by integrating this constructed DLS scale into the model that enterprises will use during their digital transformation process, they can enhance the effect of digital transformation on financial performance as well. In other words, using this proposed model, enterprises can gain useful insights into the process of digital transformation and make well-informed choices about the integration of DLS into their digital transformation plans.

Contribution & Value Added: In this study, we constructed a novel scale to determine the digital leadership skills of the leaders who will lead the digital transformation process in enterprises. Moreover, we introduced to the literature a different model that can evaluate the effects of digital leadership skills on organisational factors, DT, and financial performance of enterprises in the digitalization process in enterprises by proposing a model that includes the constructed scale.

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INTRODUCTION

Globalization has put great pressure on businesses in recent years, forcing them to digitalize and increase their productivity to compete with their competitors in the world. Digital transformation (DT)

is critical for companies seeking to preserve or increase their market share in the digital age. Digital transformation is a term that expresses the changes related to the use of digital technology in all areas of a person's life (Kääriäinen *et al.*, 2021). Leadership refers to having the ability to direct, motivate, and manage employees in an organisation to achieve the organisation's mission and goals (Winston & Patterson, 2006). 'Digital leadership' pertains to individuals in leadership positions who execute various leadership processes electronically (El Sawy *et al*., 2016). An effective digital leader will contribute to formulating the digital business strategy, leading to exceptional business success (Araujo *et al*., 2021). As Klein (2020) indicates, digital leaders are expected to be adaptable to organisational structures. Consequently, the presence of digital leadership in the DT process is crucial to align technology with strategic goals, improve adaptability, and ensure effective change management. The absence of a digital leader in the DT process will result in inefficient implementation and waste of resources, resulting in a slower and more effective digital transformation and a digital transformation process with little competitive power in the potential market. However, a standard digital leadership model is lacking. While most existing research is visionary and predicts the necessities for digital leadership based on predicted technological, economic, and organisational variations, limited research documents adjustments in leadership based on implemented cases. There has been little research on the topic in the organisational literature; this study summarizes the main characteristics of leadership in the digital transformation era. As a result, more scientific research on digital leadership qualities and impact is required in the future. Scholars should design new studies in this context to establish a quantifiable scale of digital leadership (Araujo *et al*., 2021).

Existing studies in the literature highlight the critical role of digital leadership in the digital transformation process. However, the existing literature lacks sufficient information on the extent of digital leadership abilities. While much has been written about general leadership and digital transformation separately, there is a lack of comprehensive, validated tools to assess digital leadership skills specifically. This scale contributes to the literature by providing a reliable measure that can serve to explore how digital leadership influences organisational success and transformation, offering both a theoretical framework and a practical tool for further studies. The main research aim is to construct a novel measurement tool called the digital leadership skills scale (DLS scale), specifically developed to evaluate proficiency in digital leadership abilities. This is of significant importance since the existing body of literature lacks a comprehensive scale for this purpose, and the results of this study may help fill this knowledge gap. Then, integrate this constructed scale as a model factor developed by Teng *et al.* (2022) and investigate its general compatibility. Moreover, in the study, we used the DLS scale to identify the digital leadership skills influencing digital transformation, organisational factors, and financial performance, respectively, and to illustrate the relationships between these factors in the proposed model. Thus, as a result of the study, we developed a scientific model that can be used in future studies to determine the effect of the digital leadership skills scale in the DT process of enterprises on financial performance. Using this proposed model, enterprises can gain valuable insights into the digital transformation process and explore how each factor influences the integration of digital leadership skills (DLS) into their digital transformation strategy. The process involved comprehensive validity and reliability analyses, integration of the scale into an existing model, and testing the proposed model using linear regression analysis. The key research questions addressed in this study were: Is the developed DLS scale reliable and valid for the measurement of the digital leadership skills of individuals in leadership positions? How do digital leadership skills influence digital transformation, organisational factors, and financial performance, what is the impact of digital transformation on financial performance, and how do organizational factors influence digital transformation? The article is organized as follows: the literature review and hypotheses development, methodology, results, discussion, and conclusion sections.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Teng *et al.* (2022) examined the correlation between digital transformation and the performance of enterprises undergoing this transformation. The study found that employees' digital skills, digital technologies, and digital transformation strategies within organisations have a positive correlation with digital

transformation and that digital transformation significantly impacts the financial performance of organisations. To summarize their findings, the researchers proposed a conceptual model, as shown in Figure 1.

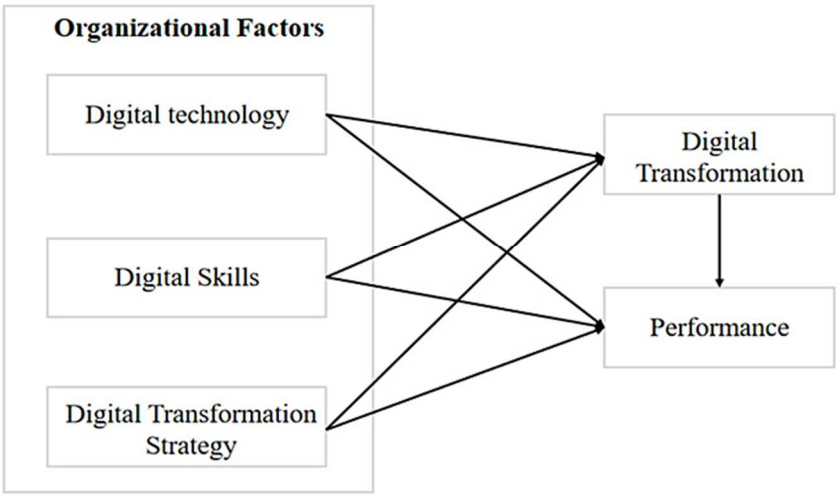

Figure 1. Conceptual model
Source: Teng *et al.*, 2022.

We analysed relevant studies to determine the most crucial competencies for a digital leader in today's world. We used the terms 'characteristics,' 'skills,' and 'traits' interchangeably to represent the multifaceted nature of the investigated concept. While these terms have distinct meanings-characteristics include both inherent and learned attributes, skills refer to acquired capabilities, and traits denote stable personality features. Here they are considered inter-connected elements that together define the construct under study in this study. Klein (2020) used a content analysis of a literature review. This study found 23 characteristics of digital leaders which are classified into three factors. The top skills in the 'digital business' dimension were 'innovative visionary,' 'networking intelligence,' and 'digital intelligence.' 'adaptable' and 'agile' were the top skills in the 'general mindset' factor. Lastly, the top skills for the 'social attitude' dimension were 'motivating coach' and 'social intelligence.' Figure 2 summarises these characteristics.

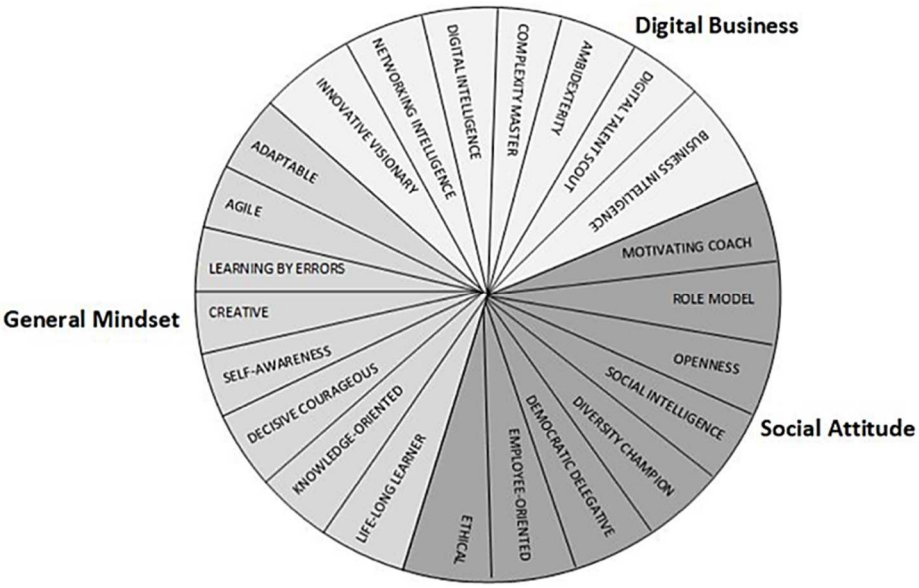

Figure 2. Digital leadership characteristics
Source: Klein, 2020.

In the digital age, technologies are constantly and rapidly changing. Determining which digital skills the leader who will lead digital transformation processes is not easy but essential. Due to a lack of research in this area, it could be difficult to determine which of the 23 acknowledged abilities a digital leader (DL) must have to efficiently lead the organisation through a DT (Klein, 2020). For this reason, some researchers explored the subject to identify some of the most crucial skills of a DL to fill this gap. Promsri (2019) identified six traits as the primary abilities that a DL must possess, which are mentioned in Table 1. On the other hand, Senadjki *et al.* (2024) stated that capabilities, experience, predictability, and vision are important for digital leaders. Interestingly, the top talents listed by Promsri (2019) and Klein (2020) have a high degree of overlap. The aim of our study is most directly related to Promsri's (2019) identification of these six characteristics as the most important abilities of a digital leader such as digital knowledge literacy, innovative vision, customer focus, agility, risk-taking, collaboration, and emphasis on their significance. As a result, we considered the top six digital leader characteristics shown in Table 1 as the basis of the digital leadership skills scale (DLS scale).

Table 1. Digital leader top six skills

Digital Leadership (DL) Characteristics	Description
Digital knowledge and literacy	DL's digital knowledge and the ability to comprehend the digital technologies which impact digital transformation (DT) in an organization.
Innovative visionary	DL's ability to have a clearly defined and stated vision and purpose for DT, and the ability to communicate that vision to employees at all levels in the organization, fostering an entrepreneurial mentality.
Customer focus	DL's requirement is to understand customers' true needs and address them while implementing the DT.
Agility	DL's capability to be flexible, agile, and adaptive for tackling the rapidly changing environment in the digital era.
Risk-taking and experimental atmosphere creation	DL enables employees throughout the organization to experiment with new products, services, and changes while embracing failure and mistakes and learning from them, also actively looking for fresh opportunities.
Emotional intelligence and collaboration	DL needs to equip themselves with high emotional intelligence which enables self-awareness, empathy, communication skills, collaborative skills, and cultural awareness. These skills encourage employees and teams to collaborate in an open and positive environment across boundaries to ensure a successful DT.

Source: Promsri (2019).

The literature defines emotional intelligence as an individual's ability to affect oneself and others to achieve goals and reach set targets (Salovey & Mayer, 1990). Emotional intelligence enhances digital leadership through effective communication and conflict management, self-awareness and decision-making, empathy, and managing relationships (Alsalminy & Omrane, 2023). Moreover, Rockstuhl *et al*. (2011) highlighted that emotional intelligence was a more significant indicator of digital leadership effectiveness in domestic settings. As a result, emotional intelligence coupled with digital leadership skills play an active role in increasing the financial performance of enterprises in the digital transformation process.

On the other hand, previous research emphasized the significance of digital transformation (Wang & Xia, 2024), the vital role of leadership (Araujo *et al.*, 2021), and, in particular, the unquestionable role of digital leaders in the success of digital transformation in the contemporary day (Persson & Manas, 2021). Moreover, the most important abilities of a digital leader have been highlighted (Klein, 2020; Porfírio *et al.*, 2021; Promsri, 2019). Digital leadership has been highlighted as one of the most understudied themes in the context of digital transformation, and more research is needed to go deeper into this topic (Malik, 2024). As a result, the main purpose of this study is to reveal that an organization's digital leadership skills are very important in influencing organisational characteristics. This, in turn, positively affects the organisation's digital transformation, which ultimately leads to enhanced financial performance. In this Table, while 'capability' refers to the potential and capacity to change and adapt in response to the evolving digital environment, such as in the case of agility and

risk-taking, 'ability' implies the present skill or competence in carrying out tasks related to digital leadership (e.g., digital knowledge, innovative vision).

Nowadays, researchers are becoming more interested in the broad and ongoing field of DT research (Vaska *et al.,* 2020; Verhoef *et al.,* 2021). However, the literature appears to lag behind the real world, with fewer studies focusing on how organisations are digitally altered (Fernández-Rovira *et al.*, 2021; Li, 2018; Warner & Wager, 2019). It has been observed that the models utilized by businesses during the digital transformation process consider client experience (Heinze *et al.*, 2018; Ramantoko *et al.*, 2018) and the competencies and attitudes of the leadership (Chonsawat & Sopadang, 2020). However, it has been noted that they do not include digital leadership skills in their DT models. Caputo *et al.* (2021) stated that it has been determined that it requires the implementation of technology as well as the redefining of important components of the business model.

On the other hand, DT requires a digital leader (Euler, 2015), and DL is critical to the success of any firm's DT (El Sawy *et al.*, 2016). The extent and manner in which leadership influences the transformation process within organisations (Singh *et al.*, 2020), as well as the importance of the company's mission to mobilize employees for DT (Porfírio *et al.*, 2021), remain subject to further examination. In addition, for businesses digitalizing their business models is essential (Scuotto *et al.*, 2021). However, achieving this is not straightforward. For instance, these models often overlook crucial leadership skills such as leadership guidance and prioritisation. This oversight creates uncertainty regarding the potential gains and outcomes of digital transformation (Gruber, 2019; Rafael *et al.*, 2020). Consequently, according to these perspectives, we hypothesised:

H1: Digital leadership skills positively influence digital transformation.

He *et al.* (2023) emphasized the function of leadership in enabling creative people and offering organized assistance support in crisis management through guiding digitalization. Moreover, Dalvi *et al.* (2013) noted the significant positive relationships between leadership, organisational change, and organisational development. Moreover, Ko *et al.* (2021) concluded that decision-makers, namely leaders, are the driving forces of digital transformation (DT) within organizations. Through these valuable research outputs, we created the following hypothesis:

H2: Digital leadership skills positively influence financial performance.

Successful digital transformation depends on considering both technological and organisational factors (Appio *et al.*, 2021). Although the concept of performance in enterprises requires a complex procedure, it depends on organisational factors and thus organisational factors should be included in the DT process (Gnizy, 2019). In the proposed model, organisational factors in enterprises consist of digital technology, digital transformation strategy, and employee digital skills. The issues of managing digital projects and accompanying infrastructure are addressed by a digital transformation strategy (DTS) (Henfridisson & Bygstad, 2013). Its objectives are to manage an organization's path toward the intended (digitally changed) future condition and to plan, prioritize, and carry out its digital transformation (DT) initiatives (Matt *et al.*, 2015). According to Wessel *et al.* (2021), digital technologies are a versatile phenomenon that enables an organization to conduct digital operations and is a key factor in digital transformation. However, Lipsmeier *et al.* (2020) and Tabrizi *et al.* (2019) also emphasize the integration of digital technology into the company's digital strategy. On the other hand, Holopainen *et al.* (2022) and Suuronen *et al.* (2022) have highlighted that digital technologies also ensure that employees within the company are strategically prepared to transition to digital operations. Therefore, Zhao *et al.* (2023) have emphasized the significant role of digital literacy among employees in the corporate digital transformation process. Thus, we put forward the subsequent hypothesis:

H3: Digital leadership skills positively influence organisational factors.

Leaders with digital skills positively affect the production, development, and ultimately the overall performance of the organisation, as they positively affect the development of employees' skills and strategic plans of businesses (Ladkin & Patrick, 2022). Persson and Manas (2021) highlighted that the leader's successful application of digital leadership skills is a necessity for the digital transformation of enterprises and is an important factor in increasing the company's financial performance at the end of

the DT process. We created the following hypothesis to determine the impact of the digital leadership role on improving financial performance in the DT process in enterprises.

H4: Organisational factors positively influence digital transformation.

Business outcomes are positively impacted by digital transformation (Hai, 2021). According to recent research, business financial performance is influenced by digital transformation (Mubarak, 2019). Furthermore, enterprise performance benefits from enterprise digital transformation (Wang & Xia, 2024). According to Wang *et al.* (2020), digital transformation consistently enhances organisational performance and positively influences both short- and long-term financial outcomes. Peng and Tao (2022) emphasized that digital transformation in enterprises increases input-output efficiency, leading to overall productivity growth. Jacobs *et al.* (2016) argue that digital transformation positively impacts the financial performance of the business. Based on these opinions, we created the subsequent hypothesis.

H5: Digital transformation positively influences financial performance.

RESEARCH METHODOLOGY

Study Design

We aimed to create a new scale, the digital leadership skills scale (DLS scale), designed to measure digital leadership skills. Subsequently, we wanted to integrate these scale items into the scale developed by Teng *et al.* (2022) as a sub-dimension and examine its overall compatibility with the previously developed model for the research on the correlation between DT and enterprises' financial performance.

Therefore, the initial phase involved the development of the DLS scale, a new measurement designed to assess digital leadership skills. As Figure 3 shows, in the subsequent phase, we integrated the items from the DLS scale as a sub-dimension into the scale developed by Teng *et al.* (2022) as shown in Figure 1. Then, we examined the overall compatibility and harmony of the integrated DLS scale items with the previously developed scale for DT.

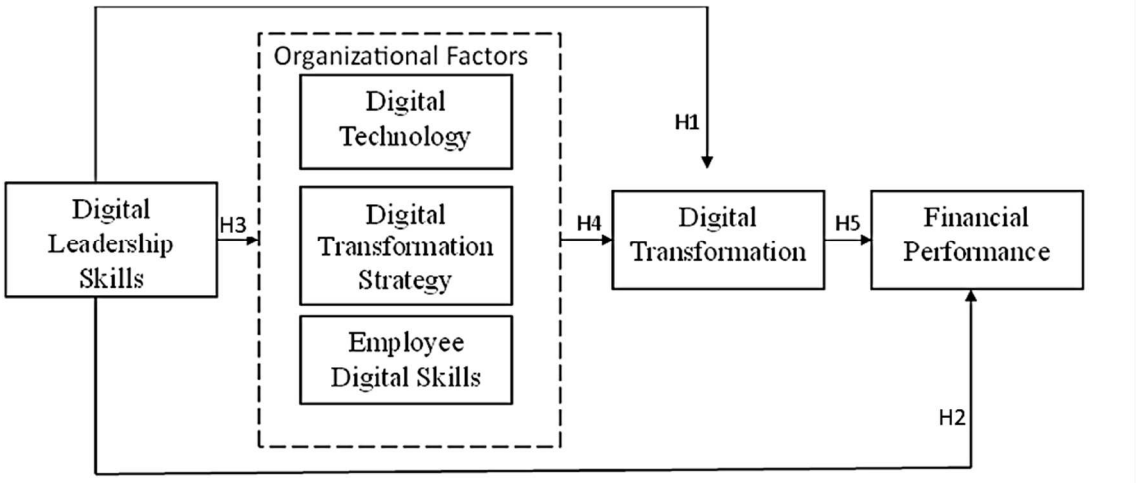

Figure 3. Proposed model
Source: own elaboration.

Participants: We selected employees active in an organization by purposeful sampling method. The online survey yielded 701 responses. The study received ethical approval from NEU Scientific Research Ethics Committee for this study (NEU/AS/2023/185).

From Table 2 we may see that participants represented different genders, different generations, different working experiences, different company sizes, different industries, different education levels, and different regions. The regions consisted of the following countries: Europe (Cyprus, Germany, Sweden, Turkey), America (Canada), Asia (Iran, UAE – United Arab Emirates), and others. There were no missing

observations in the data. Mahalanobis distance was utilized for the analysis of multivariate outlier observations. Based on Mahalanobis distance results, we found no outlier data points in the dataset.

Table 2. Demographic information of the participants

Demographic	Variable	Frequency (for first set n1=351)	%	Frequency (for second set n2=350)	%	Frequency (for all observations n=701)	%
Gender	Male	201	57.26%	275	78.57%	**476**	67.9%
	Female	149	42.45%	75	21.43%	224	32.0%
	Other	1	0.28%	0	0.00%	1	0.1%
What is your birth year?	Baby Boomer (1946-1964)	3	0.86%	2	0.57%	5	0.7%
	Generation X (1965-1980)	21	6.00%	14	3.99%	35	5.0%
	Generation Y or Millennials (1981-1996)	241	68.86%	168	47.86%	409	58.3%
	Generation Z (1997-2004)	86	24.57%	166	47.29%	252	35.9%
Years of working experience	1-3 Years	39	11.14%	30	8.55%	69	9.8%
	4-5 Years	75	21.43%	89	25.36%	164	23.4%
	6-10 Years	154	44.00%	143	40.74%	297	42.4%
	> 10 Years	83	23.71%	88	25.07%	171	24.4%
Company size	< 10 Employees	38	10.86%	33	9.40%	71	10.1%
	10-50 Employees	189	54.00%	213	60.68%	402	57.3%
	51-250 Employees	64	18.29%	50	14.25%	114	16.3%
	> 250 Employees	60	17.14%	54	15.38%	114	16.3%
Industry	Information and communications echnology	203	57.83%	275	78.57%	478	68.2%
	Education	71	20.23%	27	7.71%	98	14.0%
	Retail	23	6.55%	10	2.86%	33	4.7%
	Food	19	5.41%	13	3.71%	32	4.6%
	Banking	12	3.42%	6	1.71%	18	2.6%
	Health and medicine	11	3.13%	8	2.29%	19	2.7%
	Other	12	3.42%	11	3.14%	23	3.3%
Education Level	PhD / Post-Doc	43	12.29%	34	9.69%	77	11.0%
	Master's Degree	89	25.43%	125	35.61%	214	30.5%
	Bachelor's Degree	212	60.57%	180	51.28%	392	55.9%
	Associate's Degree	2	0.57%	1	0.28%	3	0.4%
	High School Diploma	5	1.43%	10	2.85%	15	2.1%
Region	Europe	194	55.27%	151	43.14%	345	49.22%
	America	99	28.21%	125	35.71%	224	31.95%
	Asia	55	15.67%	67	19.14%	122	17.40%
	Others	3	0.85%	7	2.00%	10	1.43%

Source: own study.

After an initial questionnaire administration, we conducted a retest of the DLS scale was conducted on a randomly selected group of 90 participants two weeks later to assess the test-retest reliability. This retest aimed to determine the consistency and stability of participants' responses over time. The decision to provide a two-week interval in the process of evaluating test-retest reliability was specifically chosen to minimize any memory effects on participant responses. A two-week period allows for a more stable assessment by reducing the influence of short-term emotional or situational changes on participants' responses. The literature suggests that a two-week period is sufficient and appropriate for reliability assessments, providing an effective timeframe to evaluate the stability of measurements without significant changes in participants' overall condition (Neuhaus *et al.*, 2023; Cavus & Sancar,

2023; Streiner *et al.*, 2014). Furthermore, we subjected the dataset to both EFA and CFA following its division into two distinct subsets. To elaborate, we separated the dataset comprising 701 cases into two groups. We used the first set of 351 case for exploratory factors for the scale development. Furthermore, we used a second set of 350 cases for confirmatory analysis, which validated the scale's structure and features. According to the literature, a sample would be split with one half being used to build a model and the other to test and validate the results from the first part (Anderson & Gerbing, 1988; Fokkema & Greiff, 2017). Splitting the sample into two for EFA and CFA strengthens the procedure of evaluating the consistency, applicability, and accuracy of the determined model. Thus, a more reliable basis is provided for the validity of the scale and test the robustness of the model. Demographic differences exist between the two data sets for EFA and CFA, such as gender, birth cohorts, work experience, company size, industry, and education. These differences can provide an opportunity to test the adaptability and robustness of the scale across various demographic and contextual groups and contribute to its potential for broader applicability.

Statistical analysis: In the study, we used a comprehensive set of analysis methods to ensure the validity and reliability of the developed DLS scale and the proposed model integrated with the DLS scale. First, we assessed the normality of items through Skewness and Kurtosis indices, which lay in the acceptable bounds as the Skewness ranging between −2 and 2 and Kurtosis values of the items varying along −7 and 7, respectively. First, we examined the content validity for the scale. Next, we analysed the dataset's suitability for factor analysis using the Barlett Sphericity Test and the Kaiser-Meyer Olkin (KMO) coefficient. Later, we utilised an exploratory factor analysis (EFA) via principal component analysis with oblimin rotation to investigate the construct validity of the scale. We evaluated reliability using the Spearman–Brown coefficient, Cronbach's alpha (CrA), and retest reliability with Intraclass correlation and Pearson correlation coefficients. Moreover, item analysis included the computation of corrected item-total correlation and CrA (when individual items were eliminated). Subsequently, we employed a Student's *t*-test to determine whether the scale's items effectively differentiated between the bottom and top 27% of the participants. Furthermore, we utilised CFA to test the validation of the structure of the factors identified in EFA. In the next stage, in addition to the analyses conducted during the development of the DLS scale, such as EFA, CFA, reliability, and item analysis, we also assessed convergent and discriminant validity to examine the overall compatibility and harmony of the integrated DLS scale items with the Teng *et al.* (2022)'s model. Then, we used a simple linear regression model to test the developed hypothesis. We conducted data analysis with the R Studio version 4.3.2.

RESULTS AND DISCUSSION

Stage 1: Development of DLS Scale

DLS Scale Items Development Procedure

At first, we created a 14-item pool for leadership skills, considering that each skill is highly relevant to a digital leader's needed skills. We examined these items' content validity. Eight senior managers of information technology (IT) assessed the 14-item trial form as part of the qualitative stage who were experienced in the leadership roles of small, medium, and large enterprises and knowledgeable in the subject area. While two of these 8 IT experts were experts in IT project management, the others were experts in digital strategy, data analytics, cyber security, system analysis, and digital marketing, respectively. We conducted a quantitative part using the content validity ratio (CVR) and index (CVI) to analyse the scale's content validity in further detail. In this stage of the process, we asked specialists to rate every component on a scale of 1 to 3, denoting 'not essential,' 'helpful but not essential,' and 'essential.' We kept items that met Lawshe's criterion for CVR scores and removed those that did not. Lawshe's criterion, which considers the opinions of eight experts, determines a critical CVR value of 0.75 (Lawshe, 1975). Furthermore, we evaluated the clarity, simplicity, relevance, and ambiguity of the content validity index for item defined as 'I-CVI' and the scale content validity defined as 'S-CVI/Ave' via the four-point-scale (Polit *et al.*, 2007; Yaghmaie, 2003).

Values lying outside of this range were adjusted appropriately, and I-CVI scores at or above 0.78 were considered acceptable; we regarded scores below 0.7 as inappropriate (Polit *et al.*, 2007). S-CVI Ave indices as the mean value of all I-CVIs were greater than or equal to 0.9 and thus were adequate. Before as well as after item elimination, we determined the mean CVR and I-CVI indices of the full scale. We found eight items to be less appropriate for inclusion in the scale and were later removed, according to the content validity rates and indices that were acquired following the experts' feedback (A leader's digital intelligence positively affects the digital transformation strategy of your enterprise; A leader's social intelligence positively affects the digital transformation strategy of your enterprise; A leader's openness abilities positively affect the digital transformation strategy of your enterprise; A leader's democratic delegation skills positively affect the digital transformation strategy of your enterprise; A leader's focus on employee orientation positively affects the digital transformation strategy of your enterprise; A leader's lifelong learning abilities positively affect the digital transformation strategy of your enterprise; A leader's ambidexterity skills positively affect the digital transformation strategy of your enterprise; A leader's decisive courage positively affect the digital transformation strategy of your enterprise). As a result of the expert's opinion, we removed eight items. Consequently, we created a 6-item measure according to the suggestions and opinions of eight experts for the creation of the DLS scale. There were 7-point Likert scale items on this scale. This scale includes seven-point Likert scale items varying from 1 (strongly disagree) to 7 (strongly agree).

EFA Results of The DLS Scale

We unequivocally analysed the DLS scale's underlying factor structure using an EFA. Our sample size was sufficient for the analysis, as KMO was as 0.908. Moreover, due to Bartlett's sphericity test, we can conclude that the dataset exhibited the normal distribution and was appropriate for analysis ($\chi2(15)= 1420.398$, $p <0.001$). From the findings of factor analysis, the DLS scale was a one-factor scale with an eigenvalue of 4.244, explaining 70.729% of the total variance. Furthermore, the component matrix showed factor loadings varying from 0.801 to 0.899. As depicted in Table 3, we measured and illustrated the factor loadings and communalities of all six items of the DLS scale.

Table 3. Items, factor loadings, and communalities

Item No	Statement	Factor loading	Communalities
1	A leader's digital knowledge and the ability to comprehend digital technologies positively affect the digital transformation strategy of your enterprise.	0.801	0.641
2	A Leader's futuristic entrepreneurial mentality, and ability to clearly define and communicate the enterprise's vision to employees, positively affect the digital transformation strategy of your enterprise	0.899	0.809
3	A leader's understanding of customers' true needs and addressing them, positively affect the digital transformation strategy of your enterprise.	0.846	0.715
4	A leader's capability to be flexible, agile, and adaptive for tackling the rapidly changing environment, positively affects the digital transformation strategy of your enterprise.	0.839	0.704
5	A leader's ability to encourage employees to experiment with new products and services, and learn from their failures, positively affects the digital transformation strategy of your enterprise.	0.851	0.725
6	A leader's emotional intelligence, self-awareness, empathy, and communication skills, positively affect the digital transformation strategy of your enterprise.	0.806	0.650

Source: own study in R-studio.

CFA Results of the DLS Scale

We employed the second group (n2=350) to test the item-factor structure established in EFA through CFA. We examined the data to see if they fit the one-factor model using the maximum likelihood estimation approach. To evaluate the compatibility of the model, we utilised various fit indices. These fit indices include standardized root mean square residual (SRMR), normed Chi-

square(χ^2/df), root mean square error of approximation (RMSEA), incremental fit index (IFI), goodness-of-fit index (GFI), comparative fit index (CFI), adjusted goodness-of-fit index (AGFI), Bentler-Bonett normed fit index (NFI), and Bentler-Bonett non-normed fit index (NNFI) (Bollen, 1986; Bollen, 1989; Schermelleh-Engel *et al.*, 2003). In the context of these fit indices, values nearing 1 indicated a favourable fit, as the values approaching 0 for RMSEA and SRMR signify a strong fit (Tabachnick *et al.*, 2013). Table 4 presents detailed fit indices for the one-factor model.

Table 4. CFA results of the DLS scale

Index	Value	Excellent fit interval	Acceptable fit interval	Fit
χ^2	22.085	$0 \leq \chi^2 \leq 2\text{df}$	$2\text{df}<\chi^2 \leq 3\text{df}$ (df=9)	Acceptable
χ^2/df	2.453	$0 \leq \chi^2/\text{df} \leq 2$	$2 < \chi^2/\text{df} \leq 3$	Acceptable
RMSEA	0.064	$\text{RMSEA} \leq 0.05$	$0.05 < \text{RMSEA} \leq 0.08$	Acceptable
SRMR	0.018	$\text{SRMR} \leq 0.05$	$0.05 < \text{SRMR} \leq 0.10$	Excellent
NFI	0.984	$\text{NFI} \geq 0.95$	$0.90 \leq \text{NFI} < 0.95$	Excellent
TLI	0.985	$\text{TLI} \geq 0.97$	$0.95 \leq \text{TLI} < 0.97$	Excellent
IFI	0.991	$\text{IFI} \geq 0.95$	$0.90 \leq \text{IFI} < 0.95$	Excellent
CFI	0.991	$0.97 \leq \text{CFI} \leq 1.00$	$0.95 \leq \text{CFI} < 0.97$	Excellent
GFI	0.928	$0.95 \leq \text{GFI} \leq 1.00$	$0.90 \leq \text{GFI} < 0.95$	Acceptable
AGFI	0.904	$0.90 \leq \text{AGFI} \leq 1.00$	$0.85 \leq \text{AGFI} < 0.90$	Excellent

Source: own study.

These results align with the predefined threshold values provided in Table 4. The suggested one-factor model for the DLS scale appeared to have good support from all fit measures, suggesting an excellent fit and validity.

Reliability Evaluation of DLS Scale

The DLS scale has quite good internal consistency, as evidenced by a CrA of 0.917. Moreover, the Spearman-Brown split-halfreliability coefficient yielded a similarly high value of 0.896. Furthermore, 90 individuals completed the scale at a 2-week interval to assess test-retest reliability, and the results were evaluated using ICC and Pearson's r. The ICC value for the overall scores was remarkably high at 0.982 ($p<0.001$), while Pearson's r also demonstrated a strong correlation of 0.989 ($p<0.001$). The data highlights the consistency of DLS scores over about two weeks.

Item Analysis Results of the DLS Scale

To evaluate the items in the DLS scale, we conducted several analyses, including corrected item-total correlation, squared multiple correlations (SMC), CrA when individual items were removed, and a t-test comparing the upper 27% and lower 27% subgroups for all items. Table 5 presents the summary of mean, standard deviation (SD), and item analysis outcomes. The results of the corrected item-total correlation ranged from 0.714 to 0.845, while SMC values fell between 0.545 and 0.731 for all scale items. Notably, the corrected item-total correlation values for all items exceeded 0.300. Furthermore, when each item was removed individually, CrA values did not surpass the overall internal consistency coefficient of 0.917. We conducted Student's *t*-test to compare mean scores between the top 27% (n=95) and bottom 27% (n=95) sets for all items, all 6 items displayed significant differences between the two groups, with t-values ranging from 16.585 to 21.784. These results indicate that the scale's items effectively distinguish participants regarding digital leadership skills and collectively assess the same behaviour.

Stage 2: Integration DLS Scale to the Proposed Model as a Factor

At this stage, we collectively evaluated the items of the proposed model together with the items from the DLS scale for the proposed model. This evaluation aimed to integrate the valid and reliable DLS scale items into the comprehensive framework of the proposed model as a complementary sub-dimension. In summary, during this phase, we thoroughly examined the integrated DLS items within the broader context of the proposed model's overall consistency and alignment. In this section, in

addition to the analyses conducted during the development of the DLS scale, such as EFA, CFA, reliability, and item analysis, we also assessed discriminant and convergent validity and performed item analysis. The factor analysis preceded an individual examination of the reliability, convergent and discriminant validity, and total scale as well as the dimensions and scale items within each dimension. It is advised that each construct's composite reliability (CR) and CrA values are above 0.70 to demonstrate validity for convergent (Hair *et al.*, 1998). Moreover, each factor's average variance extracted (AVE) value needs to be greater than 0.5 (Fornell & Larcker, 1981). We tested the discriminant validity using the Fornell-Larcker criteria (Fornell & Larcker, 1981).

Table 5. Item analysis findings of the DLS scale

Item	$\bar{x}$ (s)	Corrected item-total correlation	SMC	CrA if item deleted	t (top 27%-bottom 27%)
1	6.34 (1.162)	0.714	0.571	0.909	18.741***
2	6.18 (1.167)	0.845	0.731	0.890	21.784***
3	6.27 (1.107)	0.771	0.596	0.901	18.479***
4	6.17 (1.099)	0.762	0.594	0.902	16.585***
5	6.28 (1.085)	0.778	0.611	0.900	19.257***
6	6.08 (1.115)	0.719	0.545	0.908	17.371***

Note: ***p<0.001.
Source: own study.

EFA Results

We applied the EFA on a set of 35 items across six scales to identify the relationships between them and group them into expected distinct factors based on their common variance. Moreover, the KMO of the sampling adequacy measure reported a value of 0.992 showing sample size adequacy. Moreover, due to Bartlett's sphericity test, we can conclude that the dataset exhibited a normal distribution and was appropriate for analysis ($\chi 2$ (528) = 8387.584, p <0.001). The results of the EFA revealed that two items, item number 17 (To what extent your enterprise uses artificial intelligence) and item number 24 (To what extent your enterprise uses cybersecurity technology), did not meet the acceptable range of factor loading, *i.e.*, they were less than 0.40. We removed these items from the study since they failed to demonstrate adequate performance during the analysis, despite being initially included under the scale of digital technology. We used the extraction method of PCA and the rotation method of Oblimin with Kaiser Normalization to derive these results. Following the removal of these two items, we refined the scale to comprise 33 items with 6 dimensions. The items within each sub-dimension demonstrated strong construct validity, aligning effectively with their respective sub-dimensions. Six dimensions together explained 69.562% of the variance in the proposed model. The revised scale demonstrated satisfactory factor loadings and communalities. The EFA successfully refined the original set of 35 items, resulting in a more robust scale comprising 33 items. This process allowed for a better understanding of the underlying factors within the data, thereby enhancing the reliability and validity of the scale for subsequent analyses. Furthermore, when we collectively assessed the proposed model's items with the DLS scale's items, we observed that the items were placed in the expected factors, and there was no structural disruption as shown in Table 6. In other words, when considered as a whole, the items were appropriately situated within the relevant sub-dimensions.

CFA Results

We assessed and confirmed the 6-factor model obtained from the EFA analysis using CFA with a sample of n2=350. To evaluate the model's fit, we employed various fit indices. The CFA results presented in Table 7 demonstrate that the proposed 6-factor model exhibits an excellent fit, confirming the 6-factor model obtained from the EFA analysis.

Discriminant-convergent Validity

Ensuring convergent validity requires that each dimension displays CR and CrA indices exceeding 0.70, with each factor's AVE being a minimum of 0.5 (Fornell & Larcker, 1981; Hair *et al.*, 1998). Our analysis

Table 6. EFA result of the proposed model

Item	Statement	Factor loading	Communalities
	Digital leadership skills (DLS)		
1	A leader's digital knowledge and the ability to comprehend digital technologies positively affect the digital transformation strategy of your enterprise.	0.702	0.670
2	A leader's futuristic entrepreneurial mentality, and ability to clearly define and communicate the enterprise's vision to employees positively affect the digital transformation strategy of your enterprise	0.916	0.819
3	A leader's understanding of customer's true needs and addressing them positively affect the digital transformation strategy of your enterprise.	0.806	0.719
4	A leader's capability to be flexible, agile and adaptive for tackling the rapidly changing environment positively affects the digital transformation strategy of your enterprise.	0.82	0.748
5	A leader's ability to encourage employees to experiment with new products and services and learn from their failures positively affect the digital transformation strategy of your enterprise.	0.839	0.735
6	A leader's emotional intelligence, self-awareness, empathy, and communication skills positively affect the digital transformation strategy of your enterprise.	0.868	0.731
	% of variance: 5.496 Eigenvalue: 1.814		
	Digital Transformation (DT)		
7	'Assess your organization's digital transformation maturity compared to peers.'	0.898	0.824
8	'Assessment of the use of digital technology.'	0.904	0.796
9	'Assess how widely your own digital technology is used.'	0.834	0.738
	% of variance: 6.491 Eigenvalue: 2.142		
	Digital Transformation Strategy (DTS)		
10	'Your company's digital transformation strategy can increase sales.'	0.645	0.681
11	'Your company's digital transformation strategy can improve competitiveness.'	0.696	0.749
12	'Your company's digital transformation strategy can fundamentally change business processes.'	0.883	0.699
13	'Your company's digital transformation strategy can improve customer experience and satisfaction.'	0.843	0.775
14	'Your company's digital transformation strategy can improve innovation capabilities.'	0.671	0.712
15	'Your company's digital transformation strategy can improve business decisions.'	0.683	0.605
16	'Your company's digital transformation strategy can improve efficiency.'	0.772	0.680
	% of variance: 38.641 Eigenvalue: 12.752		
	Digital Technology (DTech)		
18	'To what extent your enterprise uses blockchain technology.'	0.822	0.658
19	'To what extent your enterprise uses cloud technologies (cloud computing, edge algorithms, cloud-edge collaboration).'	0.687	0.641
20	'To what extent your enterprise uses big data and data analysis.'	0.635	0.606
21	'To what extent your enterprise uses mobile technology 4.5G-5G.'	0.712	0.655
22	'To what extent your enterprise uses the Internet of Things (IoT).'	0.693	0.743
23	'To what extent your enterprise uses social media (collaboration technology).'	0.689	0.463
	% of variance: 4.310 Eigenvalue: 1.422		
	Employee Digital Skills (EDS)		
25	'We advance continuous learning in digital technologies.'	0.695	0.726
26	'A balance between general digital skills and specialized digital roles is adequate.'	0.691	0.706
27	'We can assemble teams with the right mix of skills for each digital project.'	0.776	0.719
28	'Employees are compound talents who understand both business and digitalization.'	0.644	0.651
29	'My organization provides employees with resources or opportunities to acquire the right digital skills for digital transformation.'	0.745	0.716

	% of variance: 3.382 Eigenvalue: 1.116		
	Financial Performance (FP)		
30	'Digital transformation of your business can help increase sales.'	0.671	0.663
31	'Digital transformation of your business can help return on sales.'	0.768	0.694
32	'Digital transformation of your business can help increase gross profit.'	0.690	0.659
33	'Your enterprise's digital transformation can help increase net profit.'	0.725	0.662
34	'Digital transformation of your business can help return on equity.'	0.651	0.787
35	'Digital transformation of your business can help return on investment.'	0.741	0.615
	% of variance: 11.243 Eigenvalue: 3.710		

Source: own study.

Table 7. CFA results for the proposed model

Index	Value	Fit
χ^2	823.290	Excellent
χ^2/df	1.715	Excellent
RMSEA	0.0409	Excellent
SRMR	0.0218	Excellent
NFI	0.9610	Excellent
NNFI	0.9817	Excellent
IFI	0.9834	Excellent
CFI	0.9833	Excellent
GFI	0.9159	Acceptable
AGFI	0.9130	Excellent

Source: own study.

reveals that all factors in the study exhibited AVE indices higher than 0.5, along with CR and CrA values exceeding 0.7 for each factor, as indicated in Table 8. WE assessed discriminant validity using the Fornell-Larcker criteria (Henseler *et al.*, 2015). Our findings, presented in Table 9, align with the Fornell-Larcker, as the AVE values' square root for each dimension passes over the correlation coefficients for each factor in the relevant columns and rows, confirming discriminant validity. Discriminant validity analysis is crucial to demonstrate that the factors of a scale are distinct from each other, each making a unique contribution. A scale must show that it measures different factors. On the other hand, convergent validity is employed to determine if a scale measures similar concepts or components across different factors. If different factors measure the same concept, this indicates that convergent validity is achieved. Therefore, the analysis results indicated that the DLS integrates with the proposed model, measuring similar concepts as a whole. Moreover, it confirmed that the factors of the scale were distinct from each other and each contributed uniquely.

Table 8. Convergent validity result for the proposed model

Dimension	CR	CrA	AVE
DLS	0.928	0.917	0.685
DT	0.911	0.854	0.773
DTS	0.897	0.815	0.558
DTech	0.857	0.811	0.502
EDS	0.836	0.798	0.506
FP	0.858	0.832	0.503

Source: own study.

Reliability Analysis Results

The proposed model demonstrated good internal consistency, as shown by CrA value of 0.942 for all 33 items. The proposed model's six dimensions each showed robust internal consistency (LS=0.917, DT=0.854, DTS=0.815, DTech=0.811, EDS=0.798, FP=0.832). When calculating the CrA value for the scale containing five dimensions without including the LS sub-dimension, we found it to be 0.851. This indi

Table 9. Discriminant validity results

Dimension	Fornell-Larcker Criteria					
	LS	DT	DTS	DTech	EDS	FP
LS	0.827	–	–	–	–	–
DT	0.612	0.879	–	–	–	–
DTS	0.619	0.515	0.747	–	–	–
DTech	0.658	0.596	0.509	0.709	–	–
EDS	0.641	0.630	0.683	0.703	0.711	–
FP	0.598	0.563	0.695	0.678	0.674	0.709

Source: own study.

cates that including the LS factor in the scale enhances the reliability of the proposed model. Furthermore, removing any particular item from either factor had no significant influence on CrA levels. Furthermore, the Spearman-Brown value of whole items on the DLS scale indicated a good value (r = 0.774). All dimensions for the proposed model dimensions also displayed favourable values, for the Spearman-Brown coefficient consistency (LS=0.857, DT=0.824, DTS=0.801, DTech=0.787, EDS=0.752, FP=0.804).

Item Analysis Results

For all factors, the item-total correlations were higher than 0.300. Moreover, the items' SMC varied from 0.485 to 0.778, all of which comfortably surpassed the 0.20 threshold in the context of item analysis as shown in Table 10 (Hooper *et al.*, 2008). Strong associations between items and their respective constructs were frequently demonstrated by those with robust item-total correlations and SMC values, which considerably improved the scale's overall validity and reliability. Furthermore, the CrA values of all items were not above the scale's total alpha value of 0.942 when we methodically removed individual elements from the scale and computed CrA. Notably, when we conducted this study for every subfactor separately, the pattern remained consistent. The item analysis yielded several important conclusions, which emphasize how crucial it is to keep all 33 items in the proposed model. These findings highlight how every item on the scale is consistent with the concept being studied and adds to the scale's general validity and reliability. In other words, when these scale items were integrated into the model developed by Teng *et al.* (2022), the DLS scale was separated from the factors in the model proposed by Teng *et al.* (2022) and was evaluated as a different sub-dimension harmoniously.

Stage 3: Hypothesis Evaluation

To evaluate the hypothesis in this study, we conducted Pearson's correlation analysis and simple linear regression analysis. Table 12 presents the analysis results. In our model, organisational factors have been considered as the total of digital technology, digital transformation strategy, and employee digital skills as in Teng's model.

Influence of DLS on DR: We can see that we have statistically verified H1 based on the simple regression results in Table 12, ($F(1.699)=115.290$; $R^2=0.142$, $p<0.01$). The regression model coefficient ($\beta=0.376$, $p<0.01$) showed that digital leadership skills have a statistically significant and positive influence on digital transformation.

Influence of DLS on FP: We have statistically verified H2 based on the simple regression results in Table 12$F(1.699)=551.627$; $R^2=0.441$, $p<0.01$). The regression model coefficient ($\beta=0.664$, $p<0.01$) showed that digital leadership skills have a statistically significant and positive influence on organisational factors.

Influence of DLS on OF: We have statistically verified H3 based on the simple regression results in Table 12 ($F(1.699)=570.279$; $R^2=0.449$, $p<0.01$). The regression model coefficient ($\beta=0.670$, $p<0.01$) showed that digital leadership skills have a statistically significant and positive influence on organisational factors.

Table 10. Item analysis for the proposed model

Item	$\bar{x}$ (s)	min-max	Corrected item-total correlation	SMC	CrA if item deleted	*t*-value (27% upper-27% lower)
			Factor 1. Leadership skills (LS)			
1	6.34 (1.162)	1-7	0.548	0.640	0.939	22.851***
2	6.18 (1.167)	1-7	0.526	0.778	0.939	21.456***
3	6.27 (1.107)	1-7	0.538	0.682	0.939	20.369***
4	6.17 (1.099)	1-7	0.572	0.691	0.939	23.562***
5	6.28 (1.085)	1-7	0.575	0.677	0.939	19.799***
6	6.08 (1.115)	1-7	0.553	0.652	0.939	20.456***
			Factor 2. Digital transformation (DT)			
7	5.29 (1.205)	1-7	0.498	0.678	0.940	17.325***
8	5.34 (1.234)	1-7	0.432	0.661	0.940	18.471***
9	5.54 (1.170)	1-7	0.465	0.602	0.940	14.955***
			Factor 3. Digital transformation strategy (DTS)			
10	5.60 (1.067)	1-7	0.614	0.683	0.939	15.698***
11	6.00 (1.207)	1-7	0.561	0.727	0.939	18.366***
12	5.54 (1.145)	1-7	0.495	0.608	0.940	17.474***
13	5.91 (1.130)	1-7	0.619	0.751	0.940	15.241***
14	6.06 (1.182)	1-7	0.622	0.711	0.940	18.470***
15	5.79 (1.182)	1-7	0.566	0.633	0.939	14.521***
16	5.91 (1.197)	1-7	0.636	0.683	0.939	19.911***
			Factor 4. Digital technology (Dtech)			
17	3.76(1.266)	1-7	0.211	0.184	0.953	1.856
18	2.96 (2.156)	1-5	0.437	0.575	0.941	17.802***
19	5.31 (1.447)	1-7	0.537	0.504	0.940	14.257***
20	5.05 (1.527)	1-7	0.595	0.644	0.940	18.332***
21	5.73 (1.619)	1-7	0.521	0.564	0.939	14.125***
22	4.27 (2.173)	1-7	0.483	0.650	0.940	19.226***
23	5.60 (1.363)	1-7	0.581	0.485	0.940	18.515***
24	4.32(1.798)	1-7	0.196	0.195	0.948	1.559
			Factor 5. Employee digital skills (EDS)			
25	5.63 (1.253)	1-7	0.707	0.673	0.940	17.846***
26	5.80 (1.331)	1-7	0.594	0.665	0.940	18.203***
27	5.37 (1.394)	1-7	0.649	0.715	0.939	14.255***
28	5.15 (1.534)	1-7	0.606	0.629	0.939	15.230***
29	5.41 (1.513)	1-7	0.673	0.675	0.940	19.655***
			Factor 6. Financial performance (FP)			
30	5.81 (1.090)	1-7	0.681	0.707	0.939	20.354***
31	5.77 (1.077)	1-7	0.707	0.713	0.939	15.277***
32	5.68 (1.078)	1-7	0.678	0.699	0.939	19.656***
33	5.60 (1.050)	1-7	0.650	0.684	0.939	22.542***
34	5.52 (1.180)	1-7	0.656	0.778	0.939	20.874***
35	5.55 (1.194)	1-7	0.662	0.673	0.939	20.412***

Note: *** p<0.001.
Source: own study.

Influence of OF on DT: From a simple linear regression model for the influence of organisational factors on digital transformation, we have statistically confirmed H4 F(1.699)=237.'923; R^2=0.254, p<0.01). The regression model coefficient (β=0.504, p<0.01) showed that organisational factors are statistically significant and positively influence digital transformation.

Influence of DT on FP: From a simple linear regression model for the influence of digital transformation on financial performance, we have statistically confirmed H5 F(1.699)=140.262; R^2=0.254,

p<0.01). The regression model coefficient (β=0.409, p<0.01) showed that digital transformation significantly positively influences financial performance.

Table 11. Pearson correlation coefficients between the factors

Variables	DLS	OF	FP	DT
DLS	1			
OF	**0.670****	1		
FP	**0.664****	**0.809****	1	
DT	**0.376****	**0.504****	**0.409****	1

Note: **p<0.01; (n=701).
Source: own study.

CONCLUSIONS

Developments in the technological field have made digital transformation necessary. All businesses must initiate digital transformation processes immediately under digital leadership. Therefore, enterprises need to recognize the significance of digital leadership skills and include digital leaders in their digital transformation processes. However, the existing body of literature lacks a comprehensive scale to measure the digital leadership skills (DLS) of leaders. For this reason, we constructed a valid and reliable tool called the digital leadership skills scale (DLS scale). Therefore, the findings of this study are important as they have the potential to address this knowledge gap. Moreover, in the study, the developed scale has been used to identify the digital leadership skills influencing Digital transformation, organisational factors, and financial performance, respectively, and to illustrate the relationships between these factors in the proposed model. By using this proposed model, enterprises may get useful insights into the process of digital transformation and investigate the impact of each factor on the integration of DLS into their digital transformation plan.

Table 12. Simple linear regression analysis Results for testing hypothesis

Statistics	B	β	Std.Error	*t*	p	95% Confidence Interval	Decision
(DLS→ DT)							H1 supported
Constant	9.521		0.655	14.541	0.000	(8.235, 10.806)	
DLS	0.188	0.376	0.018	10.737	0.000	(0.154, 0.222)	
Model 1 summary: R^2=0.142; F(1.699)= 115.290; p=0.000							
(DLS→ FP)							H2 supported
Constant	10.824		0.978	11.070	0.000	(8.905, 12.744)	
DLS	0.614	0.664	0.026	23.487	0.000	(0.563, 0.666)	
Model 3 summary: R^2=0.441; F(1.699)= 551.627; p=0.000							
(DLS→ OF)							H3 supported
Constant	33.296		2.666	12.488	0.000	(28.062, 38.531)	
DLS	1.703	0.670	0.071	23.881	0.000	(1.563, 1.843)	
Model 2 summary: R^2=0.449; F(1.699)= 570.279;p=0.000							
(OF→ DT)							H4 supported
Constant	6.930		0.626	11.079	0.000	5.702, 8.159)	
OF	0.099	0.504	0.006	15.425	0.000	(0.087, 0.112)	
Model 4 summary: R^2=0.254; F(1.699)= 237.923; p=0.000							
(DT→ FP)							H5 supported
Constant	21.036			1.069	0.000	(18.938, 23.135)	
DT	0.757	0.409		0.064	0.000	(0.631, 0.882)	
Model 5 summary: R^2=0.167; F(1.699)= 140.262; p=0.000							

B: Unstandardised coefficient, β: Standardised coefficient.
Source: own study.

Theoretical Implications

The present study significantly contributes to the existing literature on the digital transformation of enterprises. Digital transformation is crucial for enterprises' survival and competitiveness (Westerman *et al.*, 2012), and effective implementation of digital transformation positively affects the financial performance of enterprises (Valdez-Juárez *et al.*, 2024). However, Fabian *et al.* (2021) stated that digital transformation has been achieved effectively by involving digital leaders and a positive relationship between digital transformation and financial performance has only emerged. A virtuous digital leader must have digital knowledge and literacy, innovative vision, net-working intelligence, digital intelligence (Klein, 2020), etc. However, a digital leader who is technologically weak will not be a role model for its employees in the enterprise's digital transformation process, will be inadequate in the technical and theoretical applications required for digital transformation, and will have a great impact on the failure of digital transformation within the enterprises. Eventually, the technologically strong digital leader ensures the success of an organisation's digital transformation (El Sawy *et al.*, 2016; Ko *et al.*, 2021; Tigre *et al.*, 2023).

Consequently, the importance of digital leadership skills in driving digital transformation and financial performance has been overlooked. Araujo *et al.* (2021) highlighted that there is a gap in the literature on digital leadership skills in the context of digital transformation. Moreover, they stated that more scientific research on the impact of digital leadership is required in the future and that a new study should be designed to establish a quantifiable scale of digital leadership. In this context, the digital leadership skills scale developed in our study addresses this gap in the literature. Moreover, we also contributed to the literature the proposed model that will guide businesses through the digital transformation process.

Practical Implications

As a result of the mandatory need for digitalization among businesses, many enterprises have initiated the digital transformation process under the leadership of digital leadership (Euler, 2015). However, studies in the literature identify a lack of advanced digital transformation models in enterprises. For this reason, we introduced the digital leadership skills scale (DLS scale) to the literature as a reliable tool to measure digital leadership skills in the context of digital transformation. Moreover, we integrated this scale into the existing model developed by Teng *et al.* (2022) and eliminated the lack of 'digital leadership skills' in the model. The developed DLS scale provides practitioners with a tool to systematically assess and develop their digital leadership skills. In this way, practitioners can conduct targeted training and development efforts in digital leadership more effectively. Moreover, the DLS scale enables leaders to track their progress over time, supporting continuous improvement in line with digital transformation goals. Moreover, the new model created will guide businesses in the digitalization process and will have a positive impact on their development in the current competitive business environment. By establishing connections with existing research in the literature and emphasizing the importance of digital leadership skills, this study has revealed the positive impact of these skills on the financial performance of businesses in their digitalization efforts. Therefore, the constructed DLS scale and proposed model make a valuable contribution to the related literature on leadership skills, digital transformation, and financial performance in enterprises' digital transformation processes.

In summary, the developed DLS scale provides enterprises with a tool to systematically assess and develop their leaders' digital leadership skills. The developed scale helps leaders identify their strengths and areas for improvement in enterprises by focusing on the core competencies required for digital transformation. In this way, practitioners can conduct targeted training and development efforts in digital leadership more effectively. Moreover, the DLS scale enables leaders to track their progress over time, supporting continuous improvement in line with enterprises' digital transformation goals.

Limitations and Future Research Direction

As with all scientific research, this study also has some limitations. The study was limited to the items in the developed new DLS scale used. Moreover, the model was limited to used factors. Since the

relationships examined and the model created are confined to these dimensions, we evaluated the research questions tested in the study within this scope.

For future work, we suggest integrating additional dimensions into the model and testing different relationships between these dimensions. Furthermore, scholars can apply the DLS scale developed in this study to different sectors within the digital transformation process, enabling a comparative analysis of the differences in digital leadership skills or commonalities between sectors. Moreover, scholars could apply structural equation modelling (SEM) as a different approach for analysing relationships in path models with latent variables, such as digital leadership skills. Using SEM may add robustness to the findings by allowing for a more comprehensive examination of the hypothesized relationships and mediating factors within the model. On the other hand, we recommend testing the scale's validity using more balanced samples in future research for EFA and CFA. This approach would allow a deeper understanding of how demographic and contextual factors such as gender, birth cohorts, work experience, company size, industry, and education influence the scale's validity.

REFERENCES

Alsalminy, B.M.K., & Omrane, A. (2023). The effects of emotional intelligence on leadership effectiveness (A prospective case study of three industrial companies in Iraq). *Journal of Positive Psychology & Wellbeing, 7*(2), 98-1006. Retrieved from https://journalppw.com/index.php/jppw/article/view/16496 November 10, 2024.

Anderson, J.C., & Gerbing, D.W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*(3), 411. https://doi.org/10.1037/0033-2909.103.3.411

Appio, F.P., Frattini, F., Petruzzelli, A.M., & Neirotti, P. (2021). Digital transformation and innovation management: A synthesis of existing research and an agenda for future studies. *Journal of Product Innovation Management, 38*(1), 4-20. https://doi.org/10.1111/jpim.12562

Araujo, L.M. de, Priadana, S., Paramarta, V., & Sunarsi, D. (2021). Digital leadership in business organizations: An overview. *International Journal of Educational Administration, Management, and Leadership, 2*(1), 45-56. https://doi.org/10.51629/ijeamal.v2i1.18

Bollen, K.A. (1986). Sample size and Bentler and Bonett's nonnormed fit index. *Psychometrika*, *51*, 375-377. https://doi.org/10.1007/BF02294061

Bollen, K.A. (1989). A new incremental fit index for general Structural Equation Models. *Sociological Methods & Research*, *17*(3), 303-316. https://doi.org/10.1177/0049124189017003004

Caputo, A., Pizzi, S., Pellegrini, M.M., & Dabić, M. (2021). Digitalization and business models: Where are we going? A science map of the field. *Journal of Business Research, 123*, 489-501. https://doi.org/10.1016/j.jbusres.2020.09.053

Cavus, N., & Sancar, N. (2023). The importance of digital signature in sustainable businesses: A scale development study. *Sustainability, 15*(6), 5008. https://doi.org/10.3390/su15065008

Chonsawat, N., & Sopadang, A. (2020). Defining SMEs' 4.0 Readiness Indicators. *Applied Sciences*, *10*(24), 8998. https://doi.org/10.3390/app10248998

Dalvi, M.R., Shekarchizadeh, A.R., & Baghsorkhi, G.R. (2013). Investigating of organizational agility components (culture, leadership, organizational change and customer services) on the organizational performance based on the satellite model (Snowa Company as a case study). *Global Journal of Pure & Applied Science and Technology, 3*(4), 15-29. Retrieved from https://api.semanticscholar.org/CorpusID:55080604 on April 4, 2024.

El Sawy, O., Amsinck, H.A., Kræmmergaard, P., & Vinther, A.L. (2016). How LEGO built the foundations and enterprise capabilities for digital leadership. *MIS Quarterly Executive, 15*(2), 141-166. Retrieved from https://aisel.aisnet.org/misqe/vol15/iss2/5 on March 27, 2024.

Euler, T. (2015). Digital leadership: Leading successfully in the age of digital transformation. *Digital Hills.* Retrieved from https://medium.com/digital-hills/digital-leadership-leading-successfully-in-the-age-of-digital-transformation-part-1-35190fdbe2a6 on June 12, 2024.

Fabian, N.E., Broekhuizen, T., & Nguyen, D.K. (2021). Digital transformation and financial performance: Do digital specialists unlock the profit potential of new digital business models for SMEs?. In A. Hinterhuber, T., Vescovi, & F. Checchinato (Eds.), *Managing Digital Transformation* (1 ed., pp. 240-258). Routledge. https://doi.org/10.4324/9781003008637-25

Fernández-Rovira, C., Álvarez Valdés, J., Molleví, G., & Nicolas-Sans, R. (2021). The digital transformation of business. Towards the datafication of the relationship with customers. *Technological Forecasting and Social Change, 162*, 120339. https://doi.org/10.1016/j.techfore.2020.120339

Fokkema, M., & Greiff, S. (2017). How performing PCA and CFA on the same data equals trouble: Overfitting in the assessment of internal structure and some editorial thoughts on It. *European Journal of Psychological Assessment, 33*(6), 399-402. Retrieved from https://econtent.hogrefe.com/doi/10.1027/1015-5759/a000460 on November 10, 2024.

Fornell, C., & Larcker, D.F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39-50. https://doi.org/10.2307/3151312

Gnizy, I. (2019). Big data and its strategic path to value in international firms. *International Marketing Review, 36*(3), 318-341. https://doi.org/10.1108/IMR-09-2018-0249

Gruber, H. (2019). Proposals for a digital industrial policy for Europe. *Telecommunications Policy, 43*(2), 116-127. https://doi.org/10.1016/j.telpol.2018.06.003

Hai, N.T. (2021). Digital transformation barriers for small and medium enterprises in Vietnam today. *Laplage em Revista (International), 7*(3A), 416-426. https://doi.org/10.24115/S2446-6220202173A1424p.416-426

Hair, J.F., Tatham, R.L., Anderson, R.E., & Black, W. (1998). *Multivariate Data Analysis with Readings*. Englewood Cliffs, NJ, USA: Prentice Hall.

He, Z., Huang, H., Choi, H., & Bilgihan, A. (2023). Building organizational resilience with digital transformation. *Journal of Service Management, 34*(1), 147-171. https://doi.org/10.1108/JOSM-06-2021-0216

Heinze, A., Griffiths, M., Fenton, A., & Fletcher, G. (2018). Knowledge exchange partnership leads to digital transformation at Hydro-X Water Treatment, Ltd. *Global Business and Organizational Excellence, 34*(3), 28-42. https://doi.org/10.1002/joe.21859

Henfridsson, O., & Bygstad, B. (2013). The generative mechanisms of digital infrastructure evolution. *MIS Quarterly, 37*(3), 907-931. https://doi.org/10.25300/MISQ/2013/37.3.11

Henseler, J., Ringle, C.M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in Variance-Based Structural Equation Modeling. *Journal of the Academy of Marketing Science*, *43*, 115-135. https://doi.org/10.1007/s11747-014-0403-8

Holopainen, M., Ukko, J., & Saunila, M. (2022). Managing the strategic readiness of industrial companies for digital operations. *Digital Business, 2*(2), 100039. https://doi.org/10.1016/j.digbus.2022.100039

Hooper, D., Coughlan, J., & Mullen, M.R. (2008). Structural Equation Modeling: Guidelines for Determining Model Fit. *Electronic Journal of Business Research Methods, 6,* 53-60. https://doi.org/10.21427/D7CF7R

Wang, D., & Xia, X. (2024). The impact of corporate digital transformation on firms' performance in utilities sector. *Heliyon, 10*(15), e23362. https://doi.org/10.1016/j.heliyon.2023.e23362

Jacobs, B.W., Kraude, R., & Narayanan, S. (2016). Operational productivity, corporate social performance, financial performance, and risk in manufacturing firms. *Production and Operations Management, 25*(12), 2065-2085. https://doi.org/10.1111/poms.12596

Kääriäinen, J., Pussinen, P., Saari, L., Kuusisto, O., Saarela, M., & Hänninen, K. (2021). Applying the positioning phase of the digital transformation model in practice for SMEs: Toward systematic development of digitalization. *International Journal of Information Systems and Project Management*, *8*(4), 24-43. https://doi.org/10.12821/ijispm080402

Klein, M. (2020). Leadership characteristics in the era of digital transformation. *Business & Management Studies: An International Journal, 8*(1), 883-902. Retrieved from https://www.bmij.org/index.php/1/article/view/1441/1275 on April 3, 2023.

Ko, A., Fehér, P., Kovacs, T., Mitev, A., & Szabó, Z. (2022). Influencing factors of digital transformation: management or IT is the driving force?. *International Journal of Innovation Science, 14*(1), 1-20. https://doi.org/10.1108/IJIS-01-2021-0007

Ladkin, D., & Patrick, C.B. (2022). Whiteness in leadership theorizing: A critical analysis of race in Bass' transformational leadership theory. *Leadership, 18*(2), 205-223. https://doi.org/10.1177/17427150211066442

Lawshe, C.H. (1975). A quantitative approach to content validity. *Personnel Psychology, 28*, 563-575. https://doi.org/10.1111/j.1744-6570.1975.tb01393.x

Lipsmeier, A., Kühn, A., Joppen, R., & Dumitrescu, R. (2020). Process for the development of a digital strategy. *Procedia CIRP, 88*, 173-178. https://doi.org/10.1016/j.procir.2020.05.031

Malik, M., Raziq, M.M., Sarwar, N., & Tariq, A. (2024). Digital leadership, business model innovation and organizational change: Role of leader in steering digital transformation. https://doi.org/10.1108/BIJ-04-2023-0283

Matt, C., Hess, T., & Benlian, A. (2015). Digital transformation strategies. *Business & Information Systems Engineering, 57*(5), 339-343. https://doi.org/10.1007/s12599-015-0401-5

Mubarak, M.F., Shaikh, F.A., Mubarik, M., Samo, K.A., & Mastoi, S. (2019). The impact of digital transformation on business performance: A study of Pakistani SMEs. *Engineering, Technology and Applied Science Research, 9*(6), 5056-5061. https://doi.org/10.48084/etasr.3201

Neuhaus, C., Camathias, C., Mumme, M., & Faude, O. (2023). The German version of the KOOS-Child questionnaire (Knee injury and Osteoarthritis Outcome Score for children) shows a good to excellent internal consistency and a high test–retest reliability in children with knee problems. *Knee Surgery, Sports Traumatology, Arthroscopy, 31*(4), 1354-1360. https://doi.org/10.1007/s00167-022-07074-4

Peng, Y., & Tao, C. (2022). Can digital transformation promote enterprise performance?—From the perspective of public policy and innovation. *Journal of Innovation & Knowledge, 7*(3), 100198. https://doi.org/10.1016/j.jik.2022.100198

Persson, J., & Manas, K. (2021). Towards the new normal: Digital transformation through digital leadership and digital transformation strategies. Dissertation. Retrieved from https://urn.kb.se/resolve?urn=urn:nbn:se:lnu:diva-103941 on June 11, 2024.

Polit, D.F., Beck, C.T., & Owen, S.V. (2007). Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Research in Nursing & Health, 30*(4), 459-467. https://doi.org/10.1002/nur.20199

Porfírio, J.A., Carrilho, T., Felício, J.A., & Jardim, J. (2021). Leadership characteristics and digital transformation. *Journal of Business Research, 124,* 610-619. https://doi.org/10.1016/j.jbusres.2020.10.058

Promsri, C. (2019). Developing model of digital leadership for a successful digital transformation. *GPHInternational Journal of Business Management, 2*(8), 1-8. Retrieved from https://gphjournal.org/index.php/bm/article/view/249 on March 25, 2023.

Rafael, L.D., Jaione, G.E., Cristina, L., & Ibon, S.L. (2020). An Industry 4.0 maturity model for machine tool companies. *Technological Forecasting and Social Change, 159*, 120203. https://doi.org/10.1016/j.techfore.2020.120203

Ramantoko, G., Fatimah, L., Pratiwi, S., & Kinasih, K. (2018). Measuring digital capability maturity: Case of small-medium Kampong-digital companies in Bandung. *Pertanika Journal of Social Sciences & Humanities, 26*(T), 215-230. Retrieved from https://myjurnal.mohe.gov.my/public/article-view.php?id=126451 on May 18, 2024.

Rockstuhl, T., Seiler, S., Ang, S., Van Dyne, L., & Annen, H. (2011). Beyond general intelligence (IQ) and emotional intelligence (EQ): The role of cultural intelligence (CQ) on cross-border leadership effectiveness in a globalized world. *Journal of Social Issues*, *67*(4), 825-840. https://doi.org/10.1111/j.1540-4560.2011.01730.x

Salovey, P., & Mayer, J.D. (1990). Emotional Intelligence. *Imagination, Cognition and Personality, 9*(3), 185-211. https://doi.org/10.2190/dugg-p24e-52wk-6cdg

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online*, *8*(2), 23-74. Retrieved from https://search.gesis.org/publication/zis-Schermelleh-EngelMoosbrugger2003Evaluating on March 10, 2024.

Scuotto, V., Nicotra, M., Del Giudice, M., Krueger, N., & Gregori, G.L. (2021). A microfoundational perspective on SMEs' growth in the digital transformation era. *Journal of Business Research, 129*, 382-392. https://doi.org/10.1016/j.jbusres.2021.01.045

Senadjki, A., Au Yong, H.N., Ganapathy, T., & Ogbeibu, S. (2024). Unlocking the potential: The impact of digital leadership on firms' performance through digital transformation. *Journal of Business and Socio-economic Development*, *4*(2), 161-177. https://doi.org/10.1108/JBSED-06-2023-0050

Singh, A., Klarner, P., & Hess, T. (2020). How do chief digital officers pursue digital transformation activities? The role of organization design parameters. *Long Range Planning, 53*(3), 101890. https://doi.org/10.1016/j.lrp.2019.07.001

Streiner, D.L., Norman, G.R., & Cairney, J. (2014). *Health Measurement Scales. A Practical Guide to Their Development and Use* (4th. Edition). Oxford University Press: New York, NY, USA.

Suuronen, S., Ukko, J., Eskola, R., Semken, R.S., & Rantanen, H. (2022). A systematic literature review for digital business ecosystems in the manufacturing industry: Prerequisites, challenges, and benefits. *CIRP Journal of Manufacturing Science and Technology, 37*, 414-426. https://doi.org/10.1016/j.cirpj.2022.02.016

Tabachnick, B.G., Fidell, L.S., & Ullman, J.B. (2013). *Using Multivariate Statistics* (Vol. 6, pp. 497-516). Boston, MA: Pearson.

Tabrizi, B., Lam, E., Girard, K., & Irvin, V. (2019). Digital transformation is not about technology. *Harvard Business Review, 13,* 1-6. Retrieved from https://www.hbsp.harvard.edu/product/H04TO3-PDF-ENG on May 5, 2024.

Teng, X., Zhong, W., & Feng, Y. (2022). Research on the relationship between digital transformation and performance of SMEs. *Sustainability, 14*(10), 6012. https://doi.org/10.3390/su14106012

Tigre, F.B., Curado, C., & Henriques, P.L. (2023). Digital leadership: A bibliometric analysis. *Journal of Leadership and Organizational Studies, 30*(1). https://doi.org/10.1177/15480518221123132

Valdez-Juárez, L.E., Ramos-Escobar, E.A., Hernández-Ponce, O.E., & Ruiz-Zamora, J.A. (2024). Digital transformation and innovation, dynamic capabilities to strengthen the financial performance of Mexican SMEs: A sustainable approach. *Cogent Business & Management*, *11*(1), 2318635. https://doi.org/10.1080/23311975.2024.2318635

Vaska, S., Massaro, M., Bagarotto, E.M., & Dal Mas, F. (2020). The digital transformation of business model innovation: A structured literature review. *Frontiers in Psychology, 11*, 539363. https://doi.org/10.3389/fpsyg.2020.539363

Verhoef, P.C., Broekhuizen, T.L., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N.E., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, *122*(C), 889-901. https://doi.org/10.1016/j.jbusres.2019.09.022

Wang, H., Feng, J., Zhang, H., & Li, X. (2020). The effect of digital transformation strategy on performance: The moderating role of cognitive conflict. *International Journal of Conflict Management, 31*(3), 441-462. https://doi.org/10.1108/IJCMA-09-2019-0166

Warner, K.S.R., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning, 52*(3), 326-349. https://doi.org/10.1016/j.lrp.2018.12.001

Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J., & Blegind-Jensen, T. (2021). Unpacking the difference between digital transformation and IT-enabled organizational transformation. *Journal of the Association for Information Systems, 22*(1), 102-129. https://doi.org/10.17705/1jais.00655

Westerman, G., Tannou, M., Bonnet, D., Ferraris, P., & McAfee, A. (2012). The digital advantage: How digital leaders outperform their peers in every industry. Retrieved from https://ide.mit.edu/sites/default/files/publications/TheDigitalAdvantage.pdf on June 11, 2024.

Winston, B.E., & Patterson, K. (2006). An integrative definition of leadership. *International Journal of Leadership Studies*, *1*(2), 6-66. Retrieved from https://www.regent.edu/journal/international-journal-of-leadership-studies/an-integrative-leadership-definition/ on January 9, 2025.

Yaghmaie, F. (2003). Content validity and its estimation. *Journal of Medical Education, 3*(1), 25-27.

Zhao, L., He, Q., Guo, L., & Sarpong, D. (2023). Organizational digital literacy and enterprise digital transformation: Evidence from Chinese listed companies. *IEEE Transactions on Engineering Management*, 1-14. https://doi.org/10.1109/TEM.2023.3241411

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Use of Artificial Intelligence

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Conflict of Interest

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