




The development and validation of a digital leadership competency scale



Authors:

Mervin Munsamy¹ 
 Nelesh Dhanpat¹ 
 Emmerentia N. Barkhuizen¹ 

Affiliations:

¹Department of Industrial Psychology and People Management, College of Business and Economics, University of Johannesburg, Johannesburg, South Africa

Corresponding author:

Emmerentia Barkhuizen,
 nbarkhuizen@uj.ac.za

Dates:

Received: 26 May 2022

Accepted: 25 Oct. 2022

Published: 26 Apr. 2023

How to cite this article:

Munsamy, M., Dhanpat, N. & Barkhuizen, E.N., 2023, 'The development and validation of a digital leadership competency scale', *Acta Commercii* 23(1), a1057. <https://doi.org/10.4102/ac.v23i1.1057>

Copyright:

© 2023. The Authors.
 Licensee: AOSIS. This work is licensed under the Creative Commons Attribution License.

Orientation: The advent of the fourth industrial revolution (4IR) and its digital disruptions require new competencies from leaders to ensure the sustainability and competitiveness of business enterprises.

Purpose of the study: The purpose of the study was to develop and validate a scale to measure the digital leadership competencies that will enable employees to remain relevant.

Motivation for the study: Despite a proliferation of empirical studies on 4IR and its impact on leadership, validated assessments of leadership competencies for the digital age are scarce.

Research approach, design and method: A quantitative research approach was followed with data collected from employees ($N = 241$) from a multinational company in the technology and engineering industry. A newly developed digital leadership competency questionnaire was distributed electronically to the respondents. The data was analysed using the SPSS and AMOS programmes. The data analyses included descriptive statistics, confirmatory factor analyses and reliability analyses.

Main findings: The results confirmed and supported a valid and reliable six-dimensional leadership competence assessment supported by sub-competencies. The six competences include embracing digital, leadership facilitating the digital drive, digital adaptiveness and resilience, cultivating a digital culture and digital skills and digital competitiveness intelligence.

Practical/managerial implications: The digital leadership competency scale can be used to assess and develop employee competencies, which will positively affect business performance.

Contribution/value-add: The study provides a holistic digital leadership competency framework that encompasses generational theory as well as levels of work theory.

Keywords: digital competency framework; digital leadership; fourth industrial revolution; leadership competence; digital leadership competency scale.

Introduction

With the advent of the fourth industrial revolution (4IR) (also referred to as Industry 4.0), the prerequisites for successful business of the future now include modifying organisational resources, skills and competences (Adamik 2018). The pace of technological advancement and subsequent change has had a substantial impact on the talent landscape as it relates to the world of work, resulting in new business and social models (Lanvin, Evans & Eduardo 2016). As such, 4IR is distinct from the earlier revolutions where technology replaced skilled jobs and complemented low-skilled jobs; 4IR technologies seem to replace low-skilled level employees and complement high-skilled level jobs (Naudé 2017). Moreover, how technology and people interact highlights the role of technologies in crafting the norms for social conduct (Huvila 2018). Schwab (2015) advocates that the evolutionary process of 4IR requires leadership to ensure that people benefit from its power and to shape the future aligned to common objectives and values. Therefore, leadership in the digital era requires building cooperation between the generations and closing the gap between strategy and operations by influencing instead of applying force, where leading now means knowing when to lead, support, coach, facilitate and collaborate with others (Kazim 2019). Consequently, digital competency development and assessment become crucial for creating the conditions of innovation and digital transformation (April & Dalwai 2019; Berghaus 2018).

This study focuses on digital leadership competencies in the technology and engineering sector. More specifically, the study's overall objective was to develop and validate a digital leadership

Read online:



Scan this QR code with your smart phone or mobile device to read online.

competency scale that will enable leaders across the organisation to remain relevant in 4IR. The technology sector is highly competitive, with significant restructuring and reorientation to meet digital business requirements. The manufacturing systems are far more integrated and customer orientated and are accelerating through exponential technologies that impact future job roles and skills requirement of employees (Kohnová, Papula & Salajová 2019). The current context within which organisations are operating is highly volatile and disruptive, which requires core business transformation, implying the transformation of the value proposition, people, processes and technologies that are fundamental to the organisation (Dahlström, Desmet & Singer 2017). Various technology organisations have issued press releases stating publicly that for their respective organisations to meet digital requirements, as brought about by 4IR, major transformation, reorientation and restructuring are required (ABB 2018; General Electric 2019; Schneider Electric 2019; Siemens 2019).

Consequently, there is increased demand for new technology, robotics and automation, which may, unfortunately, result in a loss of jobs but are required to improve safety standards, given fatalities suffered, for example, in the mining industry (Du Venage 2018). How technology and people interact highlights the role of technology in crafting the norms for social conduct (Huvila 2018). According to Fagan (2014), technology enables people to collaborate and improve their performance by automating business processes, allowing work to be conducted more effectively and efficiently. Information technology (IT) enhances information responsiveness, facilitates communication and improves business decision-making (Bennett & Bierema 2010).

Research is required to provide insights for managers and employees on understanding digitalisation and its impact on organisations (Berghaus 2018). Moloi (2021) further advocates a need for a digital leadership competency framework and measurement scale, as employers are increasingly embarking on hiring young talent with the requisite digital skills, such as problem-solving, interpersonal and team skills for job roles. In addition, technology capability is required at all levels of the organisation, starting with competent digital change leadership and strategic positioning from the board, which contributes to the competitive advantage of a business over its peers (Valentine & Stewart 2015).

This article is intended to address the development and validation of the digital leadership competency framework scale, which is focused on the engineering and technology sector. It is therefore aimed at human resource practitioners, leaders and managers in the engineering and technology sector. The focus on developing employees' digital leadership competencies remains a priority as organisations shift their strategic focus to meet evolving market demands, given the advent of the 4IR. The present study's findings will highlight the digital leadership competencies required for organisational leaders to remain relevant. According to Windt, Borgman

and Chintan (2019), leadership is significant in establishing direction, aligning people and motivating during organisational transformation.

This research forms part of a broader study and will report and present the quantitative results of the study, that is, the metric properties of the leadership digital competency assessment developed based on the qualitative findings in Phase 1. Next, a literature review is presented on the digital leadership competencies identified.

Literature review

Theoretical foundation of the measurement

Competency frameworks

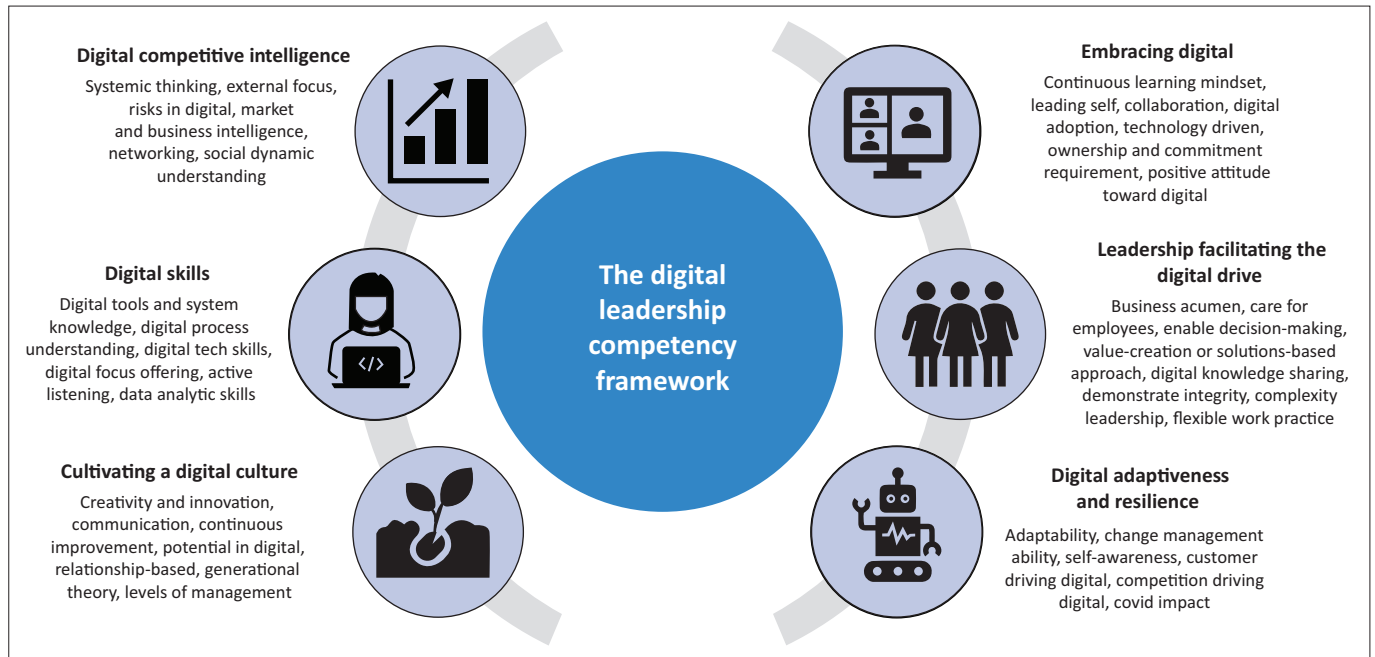
Woodruffe (1993) defined competency as 'the set of behaviour patterns that the incumbent needs to bring to a position to perform its tasks and function with competence' (p. 29). Woodruffe stated that 'competencies are about people exhibiting the behaviours required to do the job effectively, and not necessarily with the job's technical skills, knowledge and abilities' (p. 30). According to Bach and Sulikova (2019), competencies may be referred to as displays of applied theory and serve as a connection between theory and practice. Capabilities or abilities are used to define competencies, which are behaviours linked to the intent and the specific context; understanding that behaviour and intent are appropriate depends on the desired outcome (Boyatzis 2008). Yukl (2012) proposes that trusted leaders are those who demonstrate values such as honesty, altruism, compassion, fairness and courage. Such leaders are more effective and consistent with notions of servant leadership, spiritual leadership and authentic leadership. Following this logic and addressing the leadership challenge, it becomes crucial to define and identify the digital leadership competency requirements in the era of 4IR, including how employees and leaders across all hierarchical levels connect psychologically with the organisation. Given the current context of 4IR, a benefit of the competency or behavioural approach is that continuous learning and development can occur to meet revised performance objectives (Portnova & Peiseniece 2020).

A framework for digital leadership competencies

A digital leadership competency framework: Munsamy (2022) recently developed a digital leadership competency framework that forms the present study's foundation. A digital framework consists of six main themes: (1) embracing digital, (2) leadership facilitating the digital drive, (3) digital adaptiveness and resilience, (4) cultivating a digital culture, (5) digital skills and (6) digital competitiveness intelligence. The framework is presented in Figure 1.

The concise six-cluster competency framework is described here:

- Embracing digital: The sub-themes that represent this cluster theme after the factor analyses now includes continuous learning mindset, leading self, collaboration,



Source: Munsamy, M., 2022, 'A digital leadership competency framework in the era of 4IR', Unpublished Doctoral thesis, University of Johannesburg.

FIGURE 1: Digital leadership competency framework.

ownership and commitment requirement and positive attitude towards digital.

- **Leadership facilitating the digital drive:** The sub-themes that represent this cluster theme after the factor analyses now includes business acumen, care for employees, value creation or solutions-based approach, digital knowledge sharing, complexity leadership approach.
- **Digital skills:** The sub-themes that represent this cluster theme after the factor analyses now includes digital adoption, big data understanding, digital technical skills and domain know-how and active listening.
- **Cultivating a digital culture:** The sub-themes that represent this cluster theme after the factor analyses now includes inclusive culture and effective working relationship.
- **Digital adaptiveness and resilience:** The sub-themes that represent this cluster theme after the factor analyses now includes adaptability, business environment and organisation support.
- **Digital competitive intelligence:** The sub-themes that represent this cluster theme after the factor analyses now includes market and business intelligence, systemic thinking approach and risks in digital approach.

Next, the theories and literature relevant to the given competencies are discussed.

Theoretical framework

Embracing digital

According to Pauliène (2017), the rapid changes in technology impacting business, together with increased global competition and complexity facing organisations, have led to a focus on leadership competency development at all levels of the organisation. The complexity leadership framework

provides a great foundation for understanding how leaders can embrace digital transformation by devising strategies and behaviours to promote creativity, learning and adaptability (Uhl-Bien, Russ & McKelvey 2007). In particular, two tenets of leadership, enabling and adaptive leadership, are relevant here. Enabling leadership allows pathways towards a common goal by structuring and enabling complex adaptive systems. Adaptive leadership encourages emergent changes by adopting generative dynamics (see Uhl-Bien et al. 2007).

According to Newman (2017), the technology transformations that characterise Industry 4.0 lend themselves substantially to transformations in various aspects of work, such as the social practice of work, work standards or processes, work identity and working relationships. How jobs will transform is mainly unknown as the business environment continues to be disrupted, and any routine or codifiable job can be automated (Lanvin et al. 2016). Adaptability and the ability to learn as changes unfold will become core competencies for the future (Drews et al. 2018). What the new jobs of the future will look like and how to prepare, educate, train and develop employees for the future workforce is likely to change radically (Kohnová et al. 2019; Lanvin et al. 2016). Curiosity and lifelong learning become vital given the evolving nature of technology, information and business processes; a passion for learning are required, together with the concept of presence, which is role-modelling the digital vision, while working with uncertainty and ambiguity is crucial to drive transformation (April & Dalwai 2019). Digitalisation success requires leadership across various organisational levels, as the transformation components invariably span organisational boundaries (Kazim 2019).

Leadership facilitating the digital drive

Organisational hierarchies are required to manage complexities in all systems, which is one of the key

propositions of stratified systems theory (Törnblom 2018). Managerial leadership systems are required to improve organisational functioning by taking advantage of the judgement and decision-making capabilities of all management levels and holding them accountable for the results obtained by their subordinates (Sonnentag 2017). A key aspect of upskilling employees in a changing context is collaboration and knowledge transfer, for example, introducing processes to encourage the sharing and transfer of knowledge among employees and fostering personal connections among all levels of employees (Agovino 2018).

Although digital transformation must involve all employees at the various hierarchical levels, top management must develop and communicate a meaningful, action-guiding and motivating digital vision (Kreutzer, Neugebauer & Pattloch 2017). According to Bennis (2007), leadership is grounded in a relationship. In its most basic form, it is a tripod, comprising of: (1) the leader or leaders, (2) the followers and (3) the common goal. Moreover, he viewed the concept of leadership as becoming increasingly collaborative with shared-power models between those leading and those being led, together with acknowledging that a deeper understanding of the preferences of upcoming generations was required, given the context of globalisation and instant communication. In addition, new and young employees with different skills and mindsets are needed when implementing new technologies; organisations, therefore, need to adopt new approaches to attract and retain young, app-savvy talent to bridge the resultant skills gap (Drews et al. 2018).

Leadership research has also distinguished between formal and informal leaders, where formal leaders lead because of their designation and informal leaders lead through their personalities (Portnova & Peiseniece 2020). Informal leaders are needed in the context of fast-paced, disruptive change, creating a need for all employees to see themselves as leaders and to act accordingly (Veldsman 2015).

Digital adaptiveness and resilience

As digitalisation is transformative by nature and initiating an organisational transformation process is a complex, ambiguous and non-routine managerial task, managers face substantial challenges in creating an environment conducive for employees to fulfilling new work requirements (Berghaus 2018). This is where organisations require a culture shift, leveraging knowledge and using technology to adapt the core of their businesses, focusing on delivering ever-evolving customer demands (Savic 2019). Furthermore, with change as a central theme for organisations (Schenk et al. 2014), trial-and-error learning indicates a substantial impact on managers and emphasises how routines can provide managers with tools for managing the change in organisational schemata (Rerup & Feldman 2011). Therefore, an understanding of how to effect change successfully becomes vital.

Leaders must rely on and empower followers with the requisite experience given the specific situation and who can

think and act differently as the environment and context change (April & Dalwai 2019). For example, the fear of change because of the implementation of new technologies requires employees to change their routine and delve into the unknown, which causes fear of making errors and resultant employee resistance (Mikulić & Štefanić 2018).

Consequently, the mindset required for solving problems in a world of extreme uncertainty and change is one of radical strategic thinking with a new sense of purpose in the belief that having solid values adds profit and social value to the organisation (Gowing & Langdon 2018). Studies relating to what next-generation leaders deem vital include shared leadership, being more inclusive and less top-down, collaboration being an essential component of leadership and adaptive qualities (Penney 2011). A more transformational leadership style is required, with effective top-down and bottom-up communication early in the change process, ensuring a strong interplay and commitment between direct managers and senior leadership (Hill et al. 2012).

Cultivating a digital culture

According to Jonsen et al. (2013), diversity is a societal reality, and inclusion of all groups in the workforce at all levels would be better for society as a whole, given society's investment in educating and developing the skills needed for the workplace. However, from a diversity perspective, there is a general lack of understanding of generational theory and generation-related drivers in leadership studies (Lau & Subedi 2019). The experiences of workers, when assigned to host countries as expatriate employees, suggest awareness of key contextual factors regarding culture and leadership as important (Guthey & Jackson 2011). According to Hill et al. (2012), transformational leadership across the various hierarchical levels of the organisation is needed, as it enables employees to transcend self-interest and embrace the collective change vision.

Studies suggest a more distributed leadership configuration during digital transformation, where pooled inclusive expertise and initiative are required (April & Dalwai 2019; Drath et al. 2008). According to Mikulić and Štefanić (2018), the most significant challenge regarding technology adoption is the human factors that will have to adapt and process complex technology and data, which is problematic for older generations. Schenk et al. (2014) advocated that the organisational climate must be conducive to change with active employee participation for success to be achieved with the transformation. As an employee, the digital user demands different leadership, collaboration and culture approaches, transforming organisational structures and routines, thereby impacting the business model and how an organisation generates value in the digital age (Berghaus 2018).

As the new context emerges, leaders must ensure that employees are made aware and prepared accordingly. Kazim (2019) suggested that a culture of learning and development

aligned with digital transformation is required from an internal perspective. Leadership effectiveness should be assessed from the perspective of multiple stakeholders with multiple criteria using objective measures. Specific emphasis should be placed on observable leadership behaviours in the context of 4IR, as they are not necessarily the same as skills, values or personality traits (Yukl 2012).

Digital skills

The challenge being posed is for organisations to acquire the new technologies on the one hand, as well as to upskill employees on effectively using and integrating the latest technology into existing and new processes (Cabigiosu & Zirpoli 2018). April and Dalwai (2019) observed various ways digital leaders may influence digital transformation, such as providing vision, purpose and advocacy. Leaders across the organisation were required to be innovative and come up with creative ideas while being business minded. In addition, leaders created conditions to experiment, such as challenging the status quo and allowing for mistakes as part of ongoing learning, and getting people to collaborate by creating an environment of trust where employees can provide their input and ideas openly.

Required future leadership skills will include social and collaborative skills. Codrington (2008) suggested a shift towards an 'emotion economy', where the differentiation of service and information will give organisations a competitive advantage. According to Ashakanasy and Humphrey (2011), it is only since 1995 that emotion and leadership began to receive due focus. In this time, the bestselling book on emotional intelligence (EQ) was published by Goleman in 1995, highlighting self-awareness as the central factor in a leader's role and stating that leaders who understand their capabilities are regarded more positively. In addition to traditional evergreen leadership characteristics, new skills, attitudes and knowledge are required, depending on the change phase. According to April and Dalwai (2019), emotional intelligence is a crucial skill where leaders play the role of coach, supporting employees with empathy through the digital transformation, as well as the ability to rely on data yet trusting intuition because of vast amounts of information, data-driven decision making, is possible, however, experience also assists in knowing which data to use.

Digital competitiveness intelligence

The duality of old and new while there are opportunities to gain efficiencies through new technology, for example, there are also opportunities in new digital capabilities (April & Dalwai 2019). As consumers embrace technology, there are escalating expectations, creating opportunities for entrepreneurs and organisations to meet these rising demands (Dawson, Hirt & Scanlan 2016).

The advent of digitalisation has necessitated a revised competency framework that would enable leaders to remain relevant in 4IR (Mdluli & Makhupe 2017). Mdluli and Makhupe (2017) suggested the Molecular Leadership

Competency Model, given digital leadership's fluid construct, being likened to constantly moving atoms, comprising the following factors: (1) *intellectual quotient* (IQ) (i.e. traditional leadership competencies required for ongoing contextual learning), (2) *EQ* (i.e. self-awareness and emotional awareness in managing people during change), (3) *digital intelligence* (DQ) (i.e. impact on both the personal attributes of the leader as well as the digital transformation of the organisation), (4) *agility and adaptability quotient* (i.e. adapting to changing environments, customer needs and behaviour patterns that largely keep up with technological change is a key competency), (5) *socio-cultural quotient* (i.e. cultural knowledge, cross-cultural skills, cultural metacognition or mindfulness and the social aspect are required, given the diverse cultures, levels and generations within the workforce) and (6) *creativity and innovation quotient* (i.e. the systemic nature of the technological revolution requires creative and innovative leadership mindsets and suggests new ways of working that require all levels of employees to act as leaders to benefit from these changes).

Dawson et al. (2016) developed a model that depicts the skills that leaders can apply in disruptive business environments. For example, where the degree of change in the nature of supply and demand is modest, organisations can create new markets, undistort demand and remove constraints on the supply side. However, where the degree of change is extreme, organisations should hyper-scale platforms, create new value propositions and reimagine business systems (Dawson et al. 2016). Thus, digitalisation needs to become central to the organisation, requiring a possible review of the business model and developing a wide range of associated capabilities (Reis et al. 2018).

To summarise, this section provided the theoretical foundation of the study and the six emergent themes that should be considered for the scale that will assess the digital leadership competencies of leaders in the ICT and engineer industry. Next, the research design for the study is presented.

Research methods and design

Research approach and philosophy

A quantitative research approach utilising a survey questionnaire was used to determine the importance and extent to which the identified competencies and sub-competencies are acknowledged and demonstrated within the various levels of the organisation. A cross-sectional study approach was used in answering the research question as input was required from the participants at a specific time (Saunders & Tosey 2012). In a cross-sectional study approach, data about the research question are collected from targeted participants, where the data are a representation of what's happening at a particular point in time (Olsen & St. George 2004).

The first stage in formulating the survey questionnaire as the measurement instrument was defining the constructs through an in-depth literature review process, which

TABLE 1: Scale development steps.

Scale development stages	Scale development steps	Application in study
Stage 1	Step 1: Content domain specification (literature review, interviews with relevant audience, focus groups)	Step 1: An in-depth literature review relating to 4IR, including leadership, generational theory, and levels of work was done. Semi-structured interviews were conducted with targeted participants, using a case study approach.
	Step 2: Item pool generation	Step 2: A pool of items were generated as a result of the literature review and qualitative interviews conducted.
	Step 3: Content validity evaluation (expert judges, relevant audience)	Step 3: The findings from the qualitative interview process were cross-checked with the research participants to ensure that the content of the outcome was as they intended. Expert input was also sought from lecturers on 4IR to ensure content validity.
Stage 2	Step 4: Questionnaire development and evaluation	Step 4: The questionnaire went through various iterations
	Step 5: Translation and back translation	Step 5: The questionnaire was conducted in English and no additional translation was required.
	Step 6: Pilot study	Step 6: The initial pilot study was conducted with the participants from the qualitative study to ensure that the responses they provided were adequately captured in the scale developed.
	Step 7: Sampling and data collection	Step 7: A non-probability purposive sampling technique was used, where 241 respondents completed the electronic survey.
Stage 3	Step 8: Dimensionality assessment	Step 8: An assessment of homogeneity or similarity of items was conducted so as not to replicate them.
	Step 9: Reliability assessment	Step 9: The methodology followed has been documented to ensure that it can be replicated complying with the reliability assessment.
	Step 10: Construct validity assessment	Step 10: The scale items have been clearly defined to ensure that the measurement is done on the intended items.

Source: Adapted from Slavec, A. & Drnovsek, M., 2012, 'A perspective on scale development in entrepreneurship research', *Economic and Business Review* 14(1), 39–62. <https://doi.org/10.15458/2335-4216.1203>

4IR, fourth industrial revolution.

followed a deductive scale development approach and then generation of the appropriate items (Hinkin 1995). The subsequent stages included scale development through assessing adequacy of the items generated, which ensured that a representative sample was selected, as well as scale evaluation ensuring construct validity (Hinkin 1995). It was important to conduct a pilot study with a smaller sample of respondents, which included 10 respondents, to assess the clarity, readability and recommend changes that may be required (Burton & Mazerolle 2011).

Study population and sampling strategy

A non-probability purposive sampling technique was used for the study (Acharya et al. 2013). This phase involved respondents from across the organisation completing the survey questionnaire. A total of 214 responses were received from employees across the various hierarchical levels within the organisation. The questionnaire included demographic data to enable the identification of the respondents' ages and the levels at which they operate within the organisation. Most of the responses were from male participants, which accounted for 78% of the responses. Regarding ethnicity, 108 responses were received from white ethnic descent employees, followed by 83 responses from African ethnic descent employees, 36 by Indian ethnic descent employees and 12 by mixed race ethnic descent employees.

In terms of language, the highest responses were from employees who indicated English as their first language with 136 responses, followed by 54 for Afrikaans and 51 for indigenous languages. The age demographics had Generation X with the highest responses of 113, followed by Millennials with 92 responses and then Baby Boomers with 36 responses. In terms of occupational level, the most responses were received from professionals with more than

5 years of experience with 118 responses. In terms of number of years in the organisation, the highest responses were received from employees with more than 10 years of experience, which were 132 responses. However, in terms of years in current position, the highest response of 125 was received from employees less than 5 years in their current role. In terms of hours worked in a week, the highest response was 155 who indicated working between 40 hours and 50 hours per week.

Research procedure

Permission for the research was sought and obtained from the Southern Africa Managing Director via the primary researcher. The University of Johannesburg provided ethical clearance before the commencement of the study. The purpose of the study was included in the introduction to the survey, which explained the purpose and nature of participant feedback (Veldsman 2017). The participant responses were kept confidential as individuals cannot be identified through their feedback provided.

Scale development

There are various steps within different phases that are involved in developing an appropriate scale, depending on the research purpose. According to Clark and Watson (2019), three components are critical for construct validity during scale development. These include: (1) substantive validity, which refers to the conceptualisation and development of an initial item pool; (2) structural validity, including item selection being aligned to the scale development and psychometric evaluation and (3) external validity as an ongoing process. Slavec and Drnovsek (2012) suggest the 10 steps and three phases method in developing a scale, which was deemed appropriate for this study because of its detailed and systematic approach and is described here. The steps are explained Table 1.

Data collection

A survey questionnaire was distributed electronically to verify and support findings discerned from the interviews conducted as part of Phase 1. The item generation for the survey instrument was based on the literature study conducted, including the understanding of current scales aligned with the research purpose (Burton & Mazerolle 2011). Content validity measures the comprehensiveness and representativeness of the content of a scale, which is obtained from the literature and representative sample used (Creswell 2014). The qualitative phase of the study assisted in determining the domain and concepts of construct that were included in the survey instrument (Yaghmale 2003). This ensured that an established set of categories were included in the survey instrument. A framework of the findings of the qualitative phase is presented earlier in this article.

The questionnaire measured six main factors relating to the themes derived from the quantitative study.

The first theme, or domain, was *embracing digital*, which had 21 items and measured: (1) ownership and commitment requirement (i.e. 'I can coach other employees on digital technologies introduced in my area of work'); (2) collaboration with stakeholders (i.e. 'I can maintain working relationships with my customers in a changing context'); (3) continuous learning mindset (i.e. 'I am able to continue my ongoing learning journey related to digitalisation'); (4) positive attitude towards digital (i.e. 'I have achieved improvement in my work when using digital technologies') and (5) leading self (i.e. 'I take accountability for actions taken during digital transformation').

The second theme was *leadership facilitating the digital drive*, which had 22 items and measured: (1) value creation or solution-based approach (i.e. 'The digital transformation decisions taken by management are in the best interests of the organisation'); (2) complexity leadership (i.e. 'Leadership demonstrates an understanding of technology when making decisions'); (3) care for employees (i.e. 'The leadership of the organisation takes care in considering the impact of digitalisation on employees') (4) digital knowledge sharing (i.e. 'There are systems in place within my organisation to ensure digital knowledge sharing') and (5) business acumen (i.e. 'Leadership decisions that are taken concerning digitalisation are based on sound business principles').

The third theme was *digital adaptiveness and resilience*, which had 13 items and measured: (1) adaptability (i.e. 'I can adapt to the implementation of new digital tools in my organisation'); (2) business environment (i.e. 'I am aware of the changes required for me to manage digital transformation') and (3) organisational support (i.e. 'I am familiar with my organisation's potential competitors that may result from digitalisation').

The fourth theme was *cultivating a digital culture*, which had 14 items and measured inclusive culture (i.e. 'there are opportunities for me to share my ideas within my organisation')

and effective work relationships (i.e. 'I am able to communicate effectively in a virtual environment').

The fifth theme was *digital skills*, which had 12 items and measured: (1) digital adoption (i.e. 'there have been new digital tools implemented in my work area'); (2) big data understanding (i.e. 'I am aware of how to access data at work'); (3) digital technical skills (i.e. 'my business supports skills development programmes for my ongoing digital learning') and (4) domain know-how (i.e. 'digitalisation has resulted in changes to business processes at work') and active listening (i.e. 'I am able to remain attentive when communicating using digital tools').

The sixth theme was *digital competitive intelligence*, which had 11 items, and measured: (1) market and business intelligence (i.e. 'I receive updates about digital market trends in my area of expertise from my organisation'); (2) systemic thinking approach (i.e. 'I am knowledgeable about how other functional areas in the organisation impact my work') and (3) risks in digital approach (i.e. 'I understand the potential risks that my organisation faces because of digitalisation').

The responses were measured on a seven-point Likert type scale ranging from 1 = Strongly Disagree to 7 = Strongly Agree. A diagrammatic framework of the theoretical constructs that form part of the measurement is presented in Figure 2.

Data analyses

The data were analysed using the SPSS and AMOS programmes (Arbuckle 2014; IBM corp. 2020). Descriptive statistics (i.e. means, standard deviations, skewness and kurtosis) and exploratory confirmatory factor analyses were applied. Hurley et al. (1997) suggest that exploratory factor analysis (EFA) may be appropriate for scale development, measurement and starting off a line of research, while confirmatory factor analysis (CFA) is ideal where measurement models have a well-developed underlying theoretical foundation. Exploratory factor analysis was used in the scale development, and CFA was used to investigate causal connections between hierarchical level and generational theory as it relates to digital leadership competencies (Hurley et al. 1997). The analysis and interpretation of the results will be performed as follows:

- **Measure of Sample Adequacy (MSA):** Hair et al. (2019) recommend that Kaiser–Meyer–Olkin (KMO) and Bartlett's test should reveal an MSA result of 0.60; $p \leq 0.05$ for a sample to be considered adequate for factor analyses.
- **EFA:** In line with the recommendations of Hair et al. (2019) and Pallant (2002), the following guidelines are followed for EFA to be considered adequate:
 - The total variance explained for the identified factor should be 60% and above
 - The cut-off points for acceptable item loadings per factor a minimum of 0.40

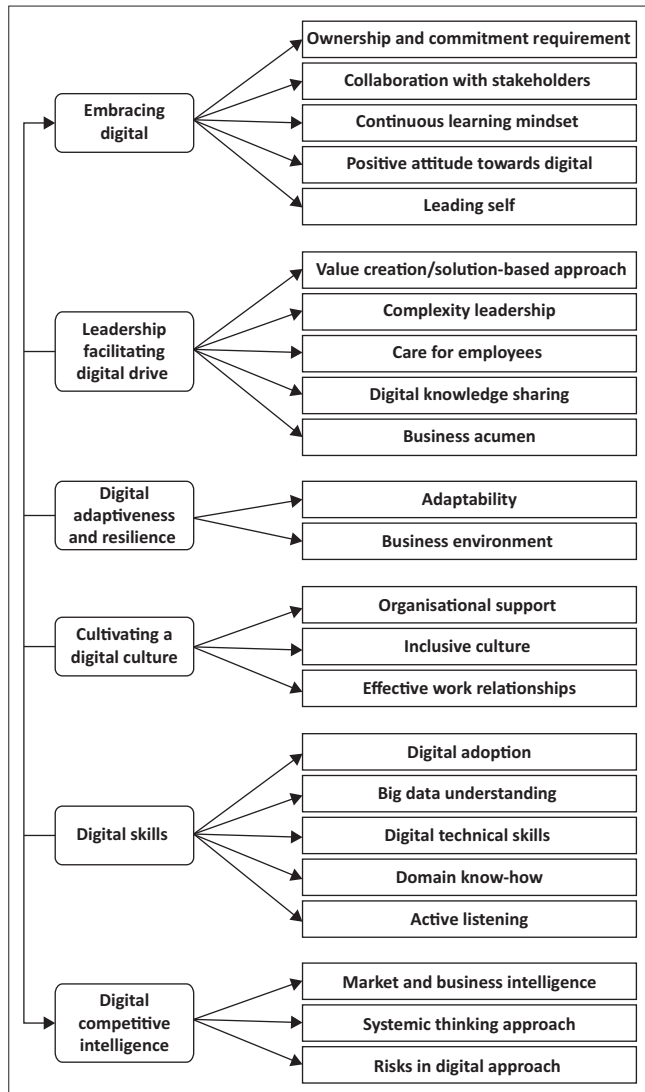


FIGURE 2: Theoretical framework for measuring instrument.

- **CFA:** In line with Hair et al. (2019), Schreiber et al. (2006) and Hu and Bentler (1999), the following goodness-of-fit indices were utilised to confirm the underlying factor structure of the measurements:
 - Chi-squared ($2 \geq \chi^2$ to $DF \geq 5$) indicates and acceptable fit
 - comparative fit index (CFI): above 0.90
 - normed fit index (NFI): above 0.90
 - Tucker–Lewis index (TLI): above 0.90
 - standardised root-mean-square residual (SRMR): 0.80 or less
 - root-mean-square error of approximation (RMSEA): 0.70 or less

A cut-off point of less than 0.85 for inter-correlations between factors is considered for distinguishable factors. Results above 0.85 indicate multi-collinearity (see Field 2019; Pallant 2002).

Reliability analyses

The guidelines of Cohen (1988) of $\alpha \geq 0.70$ were used as guideline to determine the reliability of the factors.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Johannesburg Department of Industrial Psychology and People Management (IPPM) Research Ethics Committee (No. IPPM-2019-378D).

Results

Factor and reliability analysis

The KMO and Bartlett's test were conducted to determine the sample adequacy for factor analysis. This was followed by an EFA to uncover the factor structure for the six main leadership competency constructs (i.e. embracing digital, leadership facilitating the digital drive, digital adaptiveness and resilience, digital skills, cultivating a digital culture and digital competitive intelligence) and sub-themes as identified during the qualitative phase of the research. The results of the exploratory factor analyses are reported first followed by the confirmatory factor analyses.

Exploratory factor analysis: Embracing digital

The KMO and Bartlett's test resulted in an acceptable MSA of 0.918. A subsequent EFA on the 21-item embracing digital measure using varimax rotation resulted in three factors, which explained 72.392% of the total variance. The factors were labelled ownership and commitment requirement (Factor 1), collaboration with stakeholders (Factor 2), continuous learning mindset (Factors 3), positive attitude towards digital (Factor 4) and leading self (Factor 5).

Exploratory factor analysis: Leadership facilitating the digital drive

The KMO and Bartlett's test resulted in an acceptable MSA of 0.940. A subsequent EFA on the 22-item leadership facilitating the digital drive measure using varimax rotation resulted in five factors, which explained 76.427% of the total variance. Two items were deleted because of problematic loadings. The factors were labelled value creation or solution-based approach (Factor 1), complexity leadership (Factor 2), care for employees (Factor 3), digital knowledge sharing (Factor 4) and business acumen (Factor 5).

Exploratory factor analysis: Digital adaptiveness and resilience

The KMO and Bartlett's test resulted in an acceptable MSA of 0.887. A subsequent EFA on the 13-item digital adaptiveness and resilience measure using varimax rotation resulted in three factors, which explained 72.761% of the total variance. Four items were deleted because of problematic loadings. The factors were labelled adaptability (Factor 1), business environment (Factor 2) and organisation support (Factor 3).

Exploratory factor analysis: Cultivating digital culture

The KMO and Bartlett's test resulted in an acceptable MSA of 0.926. A subsequent EFA on the 14-item cultivating digital culture measure using varimax rotation resulted in two factors, which explained 66.360% of the total variance. Two

items were deleted because of problematic loadings. The factors were labelled inclusive culture (Factor 1) and effective working relationships (Factor 2).

Exploratory factor analysis: Digital skills

The KMO and Bartlett's test resulted in an acceptable MSA of 0.907. A subsequent EFA on the 12-item digital skills measure using varimax rotation resulted in four factors, which explained 81.710% of the total variance. One item was deleted because of problematic loadings. The factors were labelled digital adoption (Factor 1), big data understanding (Factor 2), digital technical skills and domain knowhow (Factor 3) and active listening (Factor 4).

Exploratory factor analysis: Digital competitive intelligence

The KMO and Bartlett's test resulted in an acceptable MSA of 0.894. A subsequent EFA on the 11-item digital competitive intelligence measure using varimax rotation resulted in three factors, which explained 78.315% of the total variance. One item was deleted because of problematic loadings. The factors were labelled market and business intelligence (Factor 1), systemic thinking approach (Factor 2) and risks in digital approach (Factor 3). The results of the EFA are summarised in Table 2.

Results of the confirmatory factor analyses

The results of the confirmatory factor analyses are reported next. Although some scholars advocate for using EFA and CFA on different data sets, there is a substantial amount of evidence available, where both factor analyses techniques

were used on a data set with a sample size too small to split, as is the case in the present study. The CFA was therefore used to confirm the final factor structure of the measurement.

Confirmatory factor analysis: Embracing digital

The EFA was followed up with CFA to finalise the factor structure of the six measurements. The ratio of the chi-squared (392.528) compared with the degrees of freedom (142) is 2.764 ($p = 0.00$), which falls within the recommended range. The results further show acceptable values of above 0.90 for the CFI (0.913), while the fit-indexes for NFI (0.872) and TLI (0.896) can be considered acceptable. The RMSEA score (0.76) is below 0.80, while the SRMR (0.53) is below the recommended 0.70. The inter-correlation between the five factors is below the guideline of 0.85 to prevent multicollinearity. Based on the given results, it can be confirmed that the embracing digital competence consists of ownership and commitment requirement, collaboration with stakeholders, continuous learning mindset, positive attitude towards digital and leading self.

Confirmatory factor analysis: Leadership facilitating the digital drive

The EFA was followed up with CFA to finalise the factor structure of the six measurements. Table 3 indicates the goodness-of-fit statistics for the five-factor model of leadership facilitating the digital drive. The ratio of the chi-squared (469.219) compared with the degrees of freedom (160) is 2.933, which falls within the recommended range. The results further show acceptable values of above 0.90 for the CFI (0.919), NFI (0.884) and TLI (0.894). The RMSEA score (0.76) is below 0.80, while the SRMR (0.70) is equal to the recommended 0.70. The inter-correlation between the five factors is below the guideline of 0.85 to prevent multicollinearity. Based on the given results, it can be confirmed that the leadership facilitating the digital drive competence consists of value creation or solution-based approach, complexity leadership, care for employees, digital knowledge sharing and business acumen.

Confirmatory factor analysis: Digital adaptiveness and resilience

Table 3 indicates the goodness-of-fit statistics for the three-factor model of digital adaptiveness and resilience. The ratio of the chi-squared compared with the degrees of freedom is 2.968 ($p = 0.00$), which falls within the recommended range. The results further show acceptable values of above 0.90 for the CFI (0.955), NFI (0.935) and TLI (0.933). The RMSEA score (0.67) is below 0.80, while the SRMR (0.38) is lower than the recommended 0.70. The inter-correlation between the three factor is below the guideline of 0.85 to prevent multicollinearity. Based on the given results, it can be confirmed that the digital adaptiveness and resilience competence consists of adaptability, business environment and organisation support.

TABLE 2: Results of the exploratory factor analyses.

Measure	Factor solution	KMO – MSA	Variance explained (%)
Embracing digital	Ownership and commitment requirement	0.918	72.392
	Collaboration with stakeholders		
	Continuous learning mindset		
	Positive attitude towards digital		
	Leading self		
Leadership facilitating the digital drive	Value creation or solution-based approach	0.940	76.427
	Complexity leadership		
	Care for employees		
	Digital knowledge sharing		
	Business acumen		
Digital adaptiveness and resilience	Adaptability	0.887	72.761
	Business environment		
	Organisation support		
Cultivating digital culture	Inclusive culture	0.926	66.360
	Effective working relationships		
Digital skills	Digital adoption	0.907	81.710
	Big data understanding		
	Digital technical skills and domain know-how		
	Active listening		
Digital competitive intelligence	Market and business intelligence	0.894	78.315
	Systemic thinking approach		
	Risks in digital approach		

MSA, Measure of Sample Adequacy; KMO, Kaiser–Meyer–Olkin.

TABLE 3: Results of the confirmatory factor analysis.

Measure	Factor solution	Goodness-of-fit indices						Inter-correlation matrix				
		χ^2/DF	CFI	NFI	TLI	RMSEA	SRMR	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
CFA: Embracing digital												
Embracing digital								1	2	3	4	5
	Ownership and commitment Requirement	392.528/142 = 2.764	0.913	0.872	0.896	0.076	0.053	.	-	-	-	-
	Collaboration with stakeholders	-	-	-	-	-	-	0.76	.	-	-	-
	Continuous learning mindset	-	-	-	-	-	-	0.88	0.70	.	-	-
	Positive attitude towards digital	-	-	-	-	-	-	0.63	0.55	0.62	.	-
	Leading self	-	-	-	-	-	-	0.73	0.70	0.69	0.69	.
CFA: Leadership facilitating digital drive												
Leadership facilitating the digital drive								1	2	3	4	5
	Value creation or solution-based approach	469.219/160 = 2.933	0.919	0.884	0.894	0.076	0.070	.	-	-	-	-
	Complexity leadership	-	-	-	-	-	-	0.83	.	-	-	-
	Care for employees	-	-	-	-	-	-	0.81	0.67	.	-	-
	Digital knowledge sharing	-	-	-	-	-	-	0.87	0.80	0.69	.	-
	Business acumen	-	-	-	-	-	-	0.69	0.62	0.72	0.58	.
CFA: Digital adaptiveness and resilience												
Digital adaptiveness and resilience								1	2	3	-	-
	Adaptability	71.229/ 24 = 2.968	0.955	0.935	0.933	0.067	0.038	.	-	-	-	-
	Business environment	-	-	-	-	-	-	0.85	.	-	-	-
	Organisation support	-	-	-	-	-	-	0.72	0.75	.	-	-
CFA: Cultivating digital culture												
Cultivating digital culture								1	2	-	-	-
	Inclusive culture	147.413/ 53 = 2.781	0.952	0.927	0.940	0.070	0.073	.	-	-	-	-
	Effective working relationships	-	-	-	-	-	-	0.76	.	-	-	-
CFA: Digital skills												
Digital skills								1	2	3	4	-
	Digital adoption	76.033/29 = 2.622	0.968	0.951	0.951	0.060	0.044	.	-	-	-	-
	Big data understanding	-	-	-	-	-	-	0.77	.	-	-	-
	Digital technical skills and domain know-how	-	-	-	-	-	-	0.77	0.66	.	-	-
	Active listening	-	-	-	-	-	-	0.80	0.77	0.70	.	-
CFA: Digital competitive intelligence												
Digital competitive intelligence								1	2	3	-	-
	Market and business intelligence	99.097/32 = 3.097	0.957	0.939	0.940	0.073	0.070	.	-	-	-	-
	Systemic thinking approach	-	-	-	-	-	-	0.73	.	-	-	-
	Risks in digital approach	-	-	-	-	-	-	0.66	0.59	.	-	-

CFA, confirmatory factor analysis; DF, degrees of freedom; CFI, comparative fit index; NFI, normed fit index; TLI, Tucker–Lewis index; SRMR, standardised root-mean-square residual; RMSEA, root-mean-square error of approximation.

Confirmatory factor analysis: Cultivating a digital culture

Table 3 indicates the goodness-of-fit statistics for the two-factor model of cultivating digital culture. The ratio of the chi-squared (147.413) compared with the degrees of freedom (53) is 2.781 ($p = 0.000$), which falls within the recommended range. The results further show acceptable values of above 0.90 for the CFI (0.952), NFI (0.927) and TLI (0.940). The RMSEA score (0.070) is below 0.80, while the SRMR (0.073) is equal to the recommended 0.70. The inter-correlation between the two factors is below the guideline of 0.85 to prevent multicollinearity. Based on the given results, it can be confirmed that the cultivating digital culture competence consists of inclusive culture and effective work relationships.

Confirmatory factor analysis: Digital skills

Table 3 indicates the goodness-of-fit statistics for the four-factor model of digital skills. The ratio of the chi-squared (76.033) compared with the degrees of freedom (29) is 2.622 ($p = 0.000$), which falls within the recommended range. The results further show acceptable values of above 0.90 for the CFI (0.968), NFI (0.951) and TLI (0.951). The RMSEA score (0.060) is below 0.80, while the SRMR (0.044) is below the recommended 0.70. The inter-correlation between the four factors is below the guideline of 0.85 to prevent multicollinearity. Based on the given results, it can be confirmed that the digital skills competence consists of digital adoption, big data understanding, digital technical skills and domain knowhow and active listening.

TABLE 4: Descriptive statistics and reliabilities of the measurements.

Measure	Factor solution	Mean	Standard deviation	Skewness	Kurtosis	α
Embracing digital	Ownership and commitment requirement	5.6108	0.88037	-0.655	0.470	0.893
	Collaboration with stakeholders	5.7853	0.82651	-0.889	1.925	0.861
	Continuous learning mindset	5.4461	0.89104	-0.531	0.294	0.866
	Positive attitude towards digital	6.1107	0.69570	-0.753	0.760	0.781
	Leading Self	5.8022	0.79061	-0.652	1.019	0.791
Leadership facilitating the digital drive	Value creation or solution-based approach	5.3017	0.90661	-0.310	-0.364	0.894
	Complexity leadership	5.5408	0.88431	-0.703	0.826	0.895
	Care for employees	5.2006	1.10465	-0.565	0.256	0.925
	Digital knowledge sharing	5.2344	1.06654	-0.718	0.618	0.870
	Business acumen	5.9046	0.88930	-0.909	1.197	0.817
Digital adaptiveness and resilience	Adaptability	5.9056	0.72468	-0.411	-0.128	0.850
	Business environment	5.5408	0.88313	-0.401	-0.097	0.753
	Organisation support	5.6328	1.03027	-1.275	3.009	0.791
Cultivating digital culture	Inclusive culture	5.4554	0.94584	-0.825	0.861	0.918
	Effective working relationships	5.2044	0.97441	-0.574	0.276	0.835
Digital skills	Digital adoption	5.6577	0.89386	-1.136	3.178	0.853
	Big data understanding	5.8485	0.93033	-0.975	1.581	0.826
	Digital technical skills and domain know-how	5.1743	1.15141	-0.662	0.392	0.864
	Active listening	5.8942	0.88283	-1.136	2.588	0.853
Digital competitive intelligence	Market and business intelligence	5.0145	1.16628	-0.610	0.456	0.891
	Systemic thinking approach	5.6473	0.87855	-0.942	2.166	0.884
	Risks in digital approach	5.6432	0.87976	-0.683	0.743	0.824

Confirmatory factor analysis: Digital competitiveness intelligence

Table 3 indicates the goodness-of-fit statistics for the three-factor model of digital competitive intelligence. The ratio of the chi-squared (99.097) compared with the degrees of freedom (32) is 3.097 ($p = 0.00$), which falls within the recommended range. The results further show acceptable values of above 0.90 for the CFI (0.957), NFI (0.939) and TLI (0.940). The RMSEA score (0.73) is below 0.80, while the SRMR (0.70) is equal to the recommended 0.70. The inter-correlation between the three factors is below the guideline of 0.85 to prevent multicollinearity. Based on the given results, it can be confirmed that the digital competitive intelligence competence consists of market and business intelligence, systemic thinking approach and risks in digital approach.

The descriptive statistics and reliabilities are reported in Table 4.

The results in Table 4 show good to excellent reliabilities for all the factors. The participants mostly agreed that all factors are important competencies for leaders in the digital age. For 'embracing digital', the participants highlighted a positive attitude towards digital as the most important sub-competency for leaders. The participants viewed business acumen as the most important leadership sub-competence to for leadership to facilitate the digital drive. Adaptability is the most important skill for digital adaptiveness and resilience. The participants considered inclusive culture as important to cultivate a digital culture. Active listening further contributes to digital skills. Finally, systemic thinking approaches are an important sub-competence of the digital competitive intelligence of leaders.

A diagrammatic outline of the final factor structures of the digital leadership competency measure is presented in Figure 3.

Discussion

The main objective of this research was to develop and validate a digital leadership competency scale that will enable leaders across the organisation to remain relevant in 4IR. The researchers used the conceptual framework of Munsamy (2022) to developed a digital leadership competency assessment tool. The results showed six primary competence dimensions for the assessment tool: (1) embracing digital, (2) leadership facilitating the digital drive, (3) digital adaptiveness and resilience, (4) cultivating a digital culture, (5) digital skills and (6) digital competitiveness intelligence.

The competence of embracing digital resulted in five underlying sub-competences that were confirmed to be valid. These sub-competencies included ownership and commitment requirement, collaboration with stakeholders, continuous learning mindset, positive attitude towards and leading self. In line with the complexity theory of leadership (Uhl-Bien et al. 2007), leaders take ownership and commit themselves to digital transformation by creating avenues for goal achievement. Furthermore, in support of Newman (2017), leaders can enhance the social practice of work, work standards or processes, work identity and working relationships by creating dynamic work environments involving all stakeholders in the digital process. According to Kazim (2019), digitalisation success depends on the effectiveness of leadership influence within and outside organisational boundaries. Embracing digital also requires adopting a continuous learning mindset, a positive attitude towards digitalisation and leading the self. As mentioned, April and Dalwai (2019), leaders need to adopt a passion for learning and create a sense of presence while role-modelling the digital vision.

Leadership facilitating the digital drive showed five underlying sub-competences: value creation or solution-based approach, complexity leadership, care for employees, digital

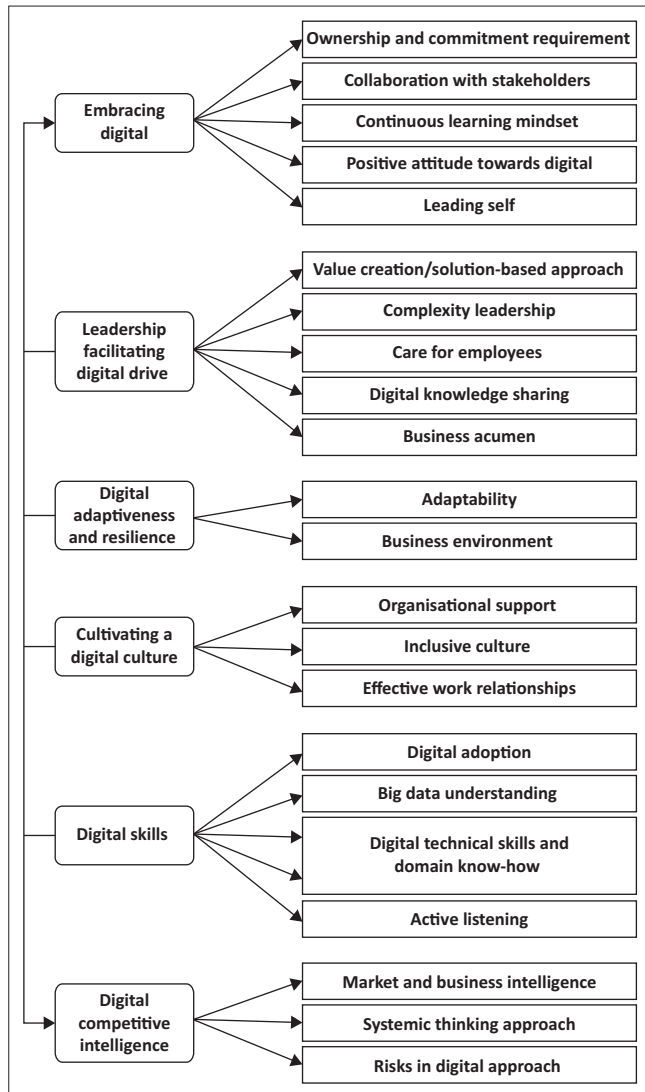


FIGURE 3: Final factor structure for measuring instrument.

knowledge sharing and business acumen. Leadership can create value and find solutions to complex leadership problems by applying the decision-making capabilities that will improve the operational functioning of organisations in the digital age (Sonnentag 2017). Leadership demonstrates care for employees when communicating a meaningful, action-guiding and motivating digital vision (Kreutzer et al. 2017) and collaborative relationships with subordinates (Bennis 2007). Agovino (2018) argues that collaboration, knowledge sharing and knowledge transfer are essential for upskilling employees while promoting personal connections between employees. Veldsman (2015) and Portnova and Peiseniece (2020) further advocates not only for a more informal and personality-based approach for leaders to create a sense of belonging for employees but also enable them to be leaders themselves in a fast-paced, disruptive work environment. Finally, leaders' business acumen will largely depend on how leaders implement new technologies that cater to the skills of multigenerational workplace talent (Drews et al. 2018).

Digital adaptiveness and resilience are another important digital leadership competency to emerge from the results.

Two sub-competencies were identified, namely adaptability and business environment. The complex and ambiguous nature of digital transformation in the business world requires leaders to create a conducive environment that allows employees to fulfil their work requirements and deliver on the continuously evolving customer demands (Berghaus 2018; Savic 2019). Leaders, therefore, need to adopt next-generation leadership skills and empower employees to think and act differently to prevent fear and resistance as daily routines are disrupted (April & Dalwai 2019; Gowing & Langdon 2018; Mikulić & Štefanić 2018; Penney 2011).

The research results also supported cultivating a digital culture as a critical digital leadership competence in the 4IR work environment. Cultivating a digital culture can be achieved through three sub-leadership competencies: organisational support, inclusive culture and effective work relationships. Organisations operate in a global space and are exposed to expatriate employees with culturally diverse backgrounds. The leadership challenge is demonstrating an understanding of the cultural environment and creating an inclusive organisational culture where employees can contribute to a collective vision for change (Guthey & Jackson 2011; Hill et al. 2012). Leaders should therefore be able to demonstrate different leadership acumen and cultural intelligence approaches to transform organisational structures and routines in support of the business model and value creation in the digital age (Berghaus 2018). In support of Kazim (2019), organisational support in the form of a culture for learning and development is required to ensure that leaders and employees acquire the skills required for digital transformation.

Concerning digital skills, the results showed support for four sub-competencies, namely digital adoption, big data understanding, digital technical skills and domain know-how and active listening. According to Cabigiosu and Zirpoli (2018), employees and leaders need to be upskilled to integrate new technology into existing processes effectively. April and Dalwai (2019) also emphasised the importance of domain know-how whereby leaders should be business-minded and adopt the innovative behaviours and creativity required to achieve the vision and purpose of digital transformation. The results of this study also concur with the emergence of the emotion economy, which advocates for the social and collaborative nature of future leadership skills (Ashakanasy & Humphrey 2011; Codrington 2008). Moreover, emotional intelligence is also vital to understanding data trends, which will assist leaders in making sense of big data and its implications for digital transformation (April & Dalwai 2019).

The last competency, digital competitiveness intelligence, includes market and business intelligence, systemic thinking approach and risks in the digital approach. The emergence of new technologies provides opportunities for acquiring new digital capabilities to understand and predict consumers' rising demands (April & Dalwai 2019; Dawson et al. 2016). In

support of the molecular leadership competency mode of Mdluli and Makhupe (2017), leaders need to adopt multiple intelligences, such as IQ for continuous contextual learning and DQ to navigate digital transformation in a complex, disruptive business environment. The creativity and innovation quotient supports creative and innovative mindsets and new systematic ways of working to adjust to the systemic nature of technology (see Mdluli & Makhupe 2017). The results also support the model of Dawson et al. (2016), which provides a helpful platform for preventing or mitigating risks in disruptive business environments characterised by supply and demand of resources.

Practical implications

From a practical perspective, the study supports human resource leaders, learning and development practitioners and line managers, who are involved in and support employee competency development. The digital leadership framework can be used to assess employees' competency gaps so that they may achieve the organisation's digital strategy. Moreover, the behavioural indicators identified for sub-competency can be used in co-creating a development plan to address the acknowledged gaps. The digital leadership competency scale, used to support and develop employee competencies, will enhance employee capability and contribute positively to business performance. The study also adds value in understanding the digital leadership competencies as complementary to existing technical requirements of a job, enabling employees to remain relevant in an era of 4IR. The framework provides insight into the digital leadership competencies required by all employees, and if acted upon, can ensure success in navigating through the current context of 4IR while achieving the organisation's digital strategy.

Limitations and recommendations

The limiting factors include that the empirical study was partial to the case study organisation in the engineering and technology sector. Consequently, further research across other industry sectors will be required to consider generalisability of the research findings. The sample was limited to respondents from the one case study organisation, which may have influenced the research findings. Therefore, the results cannot be generalised to other industry sectors. The online survey instrument was developed and conducted in English and may have impacted the respondents' level of understanding and interpretation. The study was cross-sectional, and, as such, the disadvantages of cross-sectional research were a limiting factor. Disadvantages include data collection at only one point in time and not over a period.

A longitudinal study can be conducted by applying the digital leadership competency scale and associated development actions and thereafter measuring the impact. The digital leadership competency framework and associated scale should be applied across other industry sectors to assess

relevance. The study focused on digital leadership competencies in relation to levels of work and generational theory, and other demographic elements such as gender impact may be added to the study.

Conclusion

Skilled and competent employees are crucial for successfully implementing new technologies aligned with an organisation's digital strategy. The study reinforces the need for leadership across all levels of the organisation and should form part of organisational development strategy. The findings highlight the need for various leadership competencies to be developed and should form part of the organisation's performance management system and the overall people development strategy. Organisations embarking on a digital journey need to ensure that the people strategy supports the digital strategy, which includes assessing the digital leadership competency requirements and implementing a co-created learning and development action plan.

Acknowledgements

Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

M.M. compiled the article. N.B. and N.D. as promoters provided editorial inputs.

Funding information

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Data availability

Data will be available for a period of 10 years and is available upon reasonable request from the corresponding author, E.N.B.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

References

- ABB, 2018, *ABB: Shaping a leader focused in digital industries*, viewed 19 April 2019, from <https://new.abb.com/news/detail/12473/abb-shaping-a-leader-focused-in-digital-industries>.
- Acharya, A.S., Prakash, A., Saxena, P. & Nigam, A., 2013, 'Sampling: Why and how of it?', *Indian Journal of Medical Specialties* 4(2), 330–333. <https://doi.org/10.7713/ijms.2013.0032>
- Adamik, A., 2018, 'Creating a competitive advantage in the age of Industry 4.0', *Management Issues* 17(2), 13–31. <https://doi.org/10.7172/1644-9584.82.1>
- Agovino, T., 2018, 'Shifting patterns: With 10,000 baby boomers leaving the workforce every day, business leaders can no longer afford to ignore the "r" word', *HR Magazine* 63(5), 54–56.

- April, K. & Dalwai, A., 2019, 'Leadership styles required to lead digital transformation', *Effective Executive* 22(2), 14–45.
- Arbuckle, J.L., 2014, *Amos (Version 23.0)* [Computer Program], IBM SPSS, Chicago, IL.
- Ashkanasy, N.M. & Humphrey, R.H., 2011, A multi-level view of leadership and emotions: Leading with emotional labor, in A. Bryman, D. Collinson, K. Grint, B. Jackson & M. Uhl-Bien (eds.), *The SAGE handbook of leadership*, pp. 365–379, SAGE Publications Ltd.
- Bach, C. & Sulikova, R., 2019, 'Competence development in theory and practice: Competence, meta-competence, transfer competence and competence development in their systematic context', *Management* 14(4), 289–304. <https://doi.org/10.26493/1854-4231.14.289-304>
- Bennett, E.E. & Bierema, L.L., 2010, 'The ecology of virtual human resource development', *Advances in Developing Human Resources* 12(6), 632–647. <https://doi.org/1.1177/1523422310394789>
- Bennis, W., 2007, 'The challenges of leadership in the modern world', *American Psychologist* 62(1), 2–5. <https://doi.org/1.1037/0003-066X.62.1.2>
- Berghaus, S., 2018, 'The fuzzy front end of digital transformation: Activities and approaches for initiating organizational change strategies', Doctoral thesis, University of St. Gallen.
- Boyatzis, R.E., 2008, 'Competencies in the 21st century', *Journal of Management Development* 27(1), 5–12. <https://doi.org/1.1108/02621710810840730>
- Burton, L.J. & Mazerolle, S.M., 2011, 'Survey instrument validity part I: Principles of survey instrument development and validation in athletic training education research', *Athletic Training Education Journal* 6(1), 27–35. <https://doi.org/10.4085/1947-380X-6.1.27>
- Cabigiosu, A. & Zirpoli, F., 2018, 'Digitalization in the Italian auto industry', *Symphona: Emerging Issues in Management* 2, 158–169. <https://doi.org/10.4468/2018.2.12cabigiosu.zirpoli>
- Clark, L.A. & Watson, D., 2019, 'Constructing validity: New developments in creating objective measuring instruments', *Psychological Assessment* 31(12), 1412–1427. <https://doi.org/10.1037/pas0000626> Constructing
- Codrington, G., 2008, *Detailed introduction to generational theory, Tomorrow Today Ltd*, viewed n.d., from <https://docplayer.net/20954286-Detailed-introduction-to-generational-theory.html>
- Cohen, J., 1988, 'Set correlation and contingency tables', *Applied Psychological Measurement* 12(4), 425–434. <https://doi.org/10.1177/014662168801200410>
- Creswell, J.W., 2014, *Research design: Qualitative, quantitative and mixed methods approaches*, 4th edn., Sage, Thousand Oaks, CA.
- Dahlström, P., Desmet, D. & Singer, M., 2017, *The seven decisions that matter in a digital transformation: A CEO's guide to reinvention*, Digital McKinsey, pp. 1–7, viewed 10 January 2020, from <https://www.coursehero.com/file/29766506/2017-seven-decisionspdf/>.
- Dawson, A., Hirt, M. & Scanlan, J., 2016, 'The economic essentials of digital strategy', *McKinsey Quarterly*, 15 March, 1–14.
- Drath, W.H., McCauley, C.D., Palus, C.J., Van Velsor, E., O'Connor, P.M. & McGuire, J.B., 2008, 'Direction, alignment, commitment: Toward a more integrative ontology of leadership', *Leadership Quarterly* 19(6), 635–653. <https://doi.org/10.1016/j.leaqua.2008.09.003>
- Drews, P., Schaudel, F., Schütte, R., Brenner, W., Ahlemann, F., Böhm, T. et al., 2018, 'The impact of digitalization on the IT department', *Business & Information Systems Engineering* 61(1), 123–131. <https://doi.org/1.1007/s12599-018-0570-0>
- Du Venage, G., 2018, 'Thousands gather at Electra', *Engineering and Mining Journal* 219(10), 70–74.
- Fagan, M.H., 2014, 'Exploring a sociomaterial perspective on technology in virtual human resource development', *Advances in Developing Human Resources* 16(3), 320–334. <https://doi.org/1.1177/1523422314532094>
- Field, A., 2019, *Discovering statistics using SPSS*, 4th edn., Sage Publications, London.
- General Electric, 2019, *Our strategy*, viewed 15 May 2021, from https://www.ge.com/sites/default/files/Strategy_Page_121714.pdf.
- Gowing, N. & Langdon, C., 2018, 'First, find your purpose', *The World Today* 74(3), 30–33.
- Guthey, E. & Jackson, B., 2011, 'Cross-cultural leadership revisited', in A. Bryman, D. Collinson, K. Grint, B. Jackson & M. Uhl-Bien (eds.), *The SAGE handbook of leadership*, pp. 165–178, Sage, Los Angeles, CA.
- Hair, J.F., Risher, J.J., Sarstedt, M. & Ringle, C.M., 2019, 'When to use and how to report the results of PLS-SEM', *European Business Review* 31(1), 2–24. <https://doi.org/10.1108/EBR-11-2018-0203>
- Hill, N.S., Seo, M.-G., Kang, J.H. & Taylor, M.S., 2012, 'Building employee commitment to change across organizational levels: The influence of hierarchical distance and direct managers' transformational leadership', *Organization Science* 23(3), 758–777. <https://doi.org/10.1287/orsc.1110.0662>
- Hinkin, T.R., 1995, 'A review of scale development practices in the study of organizations', *Journal of Management* 21(5), 967–988. <https://doi.org/10.1177/014920639502100509>
- Hu, L.T. & Bentler, P.M., 1999, 'Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives', *Structural Equation Modeling* 6(1), 1–55. <https://doi.org/10.1080/10705519909540118>
- Hurley, A.E., Scandura, T.A., Schriesheim, C.A., Brannick, M.T., Seers, A., Vandenberg, R.J. et al., 1997, 'Exploratory and confirmatory factor analysis: Guidelines, issues, and alternatives', *Journal of Organizational Behavior* 18(6), 667–683. [https://doi.org/10.1002/\(SICI\)1099-1379\(199711\)18:6%3C667::AID-JOB874%3E3.0.CO;2-T](https://doi.org/10.1002/(SICI)1099-1379(199711)18:6%3C667::AID-JOB874%3E3.0.CO;2-T)
- Huvila, I., 2018, 'Putting to (information) work: A Stengersian perspective on how information technologies and people influence information practices', *Information Society* 34(4), 229–243. <https://doi.org/10.1080/01972243.2018.1463332>
- IBM Corp., 2020, *IBM SPSS Statistics for Windows, Version 27.0*, IBM Corp., Armonk, NY.
- Jensen, K., Tatli, A., Ozbilgin, M.F. & Bell, M.P., 2013, 'The tragedy of the commons: Reframing workforce diversity', *Human Relations* 66(2), 271–294. <https://doi.org/1.1177/0018726712466575>
- Kazim, F.A.B., 2019, 'Digital transformation and leadership style: A multiple case study', *ISM Journal* 3(1), 24–33.
- Kohnová, L., Papula, J. & Salajová, N., 2019, 'Internal factors supporting business and technological transformation in the context of industry 4.0', *Business: Theory and Practice* 20(13), 137–145.
- Kreutzer, R.T., Neugebauer, T. & Pattloch, A., 2017, *Digital business leadership: Digital transformation, business model innovation, agile organization, change management*, Springer, Berlin.
- Lanvin, B., Evans, P. & Eduardo, R.-M., 2016, 'Shifting gears: How to combine technology and talent to shape the future of work', in B. Lanvin & P. Evans (eds.), *The global talent competitiveness index 2017*, pp. 3–34, INSEAD, Zurich.
- Lau, W.K. & Subedi, D., 2019, 'Examine the effect of generation in leadership process: A cross-cultural study in America and China', *International Journal of Business & Applied Sciences* 8(1), 22–29.
- Mdluli, S. & Makhope, O., 2017, *Defining leadership competencies needed for the fourth industrial revolution: Leadership competencies 4*, Duke CE, Durham.
- Mikulić, I. & Štefanić, A., 2018, 'The adoption of modern technology specific to industry 4.0 by human factor', in B. Katalinic (ed.), *Proceedings of the 29th DAAAM international symposium*, pp. 0941–0946, DAAAM International, Vienna.
- Moloi, T., 2021, 'Key features of the fourth industrial revolution in South Africa's basic education system', *Journal of Management Information and Decision Sciences* 24(5), 1–20.
- Munsamy, M., 2022, 'A digital leadership competency framework in the era of 4IR', Unpublished Doctoral thesis, University of Johannesburg.
- Naudé, W., 2017, *Entrepreneurship, education and the fourth industrial revolution in Africa*, IZA DP No. 10855, IZA Institute of Labor Economics, Bonn.
- Newman, T., 2017, 'Work-related literacy education in the Fourth Industrial Revolution: An update on the Literacy 4.0 Project', *Journal of the Adult Literacy and Basic Education Council* 42(3), 20–23.
- Olsen, C. & St. George, D.M.M., 2004, *Cross-sectional study design and data analysis*, College Entrance Examination Board, New York, NY.
- Pallant, J., 2002, *A step by step guide to data analysis using IBM SPSS*, 7th edn., Routledge, London.
- Pauliène, R., 2017, 'Interaction between managerial competencies and leadership in business organisations', *Regional Formation and Development Studies* 1(21), 98–108. <https://doi.org/10.15181/rfds.v21i1.1412>
- Penney, S.H., 2011, 'Voices of the future: Leadership for the 21st century', *Journal of Leadership Studies* 5(3), 55–62. <https://doi.org/10.1002/jls.20233>
- Portnova, I. & Peiseniece, L., 2020, 'Leaders' competences for successful leadership of invention and implementation of innovation: A conceptual model', *Journal of Business Management* 6(1), 40–55.
- Reis, J., Amorim, M., Melão, N., Matos, P., 2018, 'Digital transformation: A literature review and guidelines for future research', in A. Rocha, H. Adeli, L.P. Reis, S. Costanzo, (eds.), *Trends and advances in information systems and technologies*, vol. 745, pp. 411–421, Springer, Cham.
- Rerup, C. & Feldman, M.S., 2011, 'Routines as a source of change in organizational schemata: The role of trial-and-error learning', *Academy of Management Journal* 54(3), 577–561. <https://doi.org/10.1002/jls.20233>
- Saunders, M. & Tosey, P., 2012, 'The layers of research design', *Rapport Winter*, 58–59.
- Savic, D., 2019, 'From digitization, through digitalization, to digital transformation', *Information Today Inc.* 43(1), 36–39.
- Schenk, H., Tshilongamulenzhe, H., Swanpoel, B. & Erasmus, B., 2014, *South African human resource management: Theory and practice*, 5th edn., Juta and Company, Cape Town.
- Schneider Electric, 2015, *Schneider Electric announces new company strategy at annual media forum*, viewed 23 March 2021, from <https://www.miningreview.com/schneider-electric-announces-new-company-strategy-at-annual-media-forum/>.
- Schreiber, J.B., Stage, F.K., King, J., Nora, A. & Barlow, E.A., 2006, 'Reporting structural equation modeling and confirmatory factor analysis results: A review', *International Journal of Educational Research* 99(6), 323–338. <https://doi.org/10.17722/ijrvt.v4i2.261>
- Schwab, K., 2015, *The fourth industrial revolution: What it means and how to respond*, Snapshot, viewed 10 March 2020, from https://cdn.lgseta.co.za/resources/research_and_reports/4IR%20Resources/The%204IR_What%20it%20Means%20and%20How%20to%20Respond_Klaus%20Schwab_2015.pdf.
- Siemens, 2019, *Siemens: Strategy overview*, viewed 17 June 2020, from <https://new.siemens.com/global/en/company/about/strategy/overview.html>.
- Slavec, A. & Drnovsek, M., 2012, 'A perspective on scale development in entrepreneurship research', *Economic and Business Review* 14(1), 39–62. <https://doi.org/10.15458/2335-4216.1203>
- Uhl-Bien, M., Russ, M. & McKelvey, B., 2007, 'Complexity leadership theory: Shifting leadership from the industrial age to the knowledge era', *Leadership Quarterly* 18(4), 298–318. <https://doi.org/10.1016/j.leaqua.2007.04.002>

- Sonnentag, S., 2017, 'A task-level perspective on work engagement: A new approach that helps to differentiate the concepts of engagement and burnout', *Burnout Research* 5, 12–20. <https://doi.org/1.1016/j.burn.2017.04.001>
- Törnblom, O., 2018, 'Managing complexity in organizations: Analyzing and discussing a managerial perspective on the nature of organizational leadership', *Behavioral Development* 23(1), 51–62. <https://doi.org/10.1037/bdb0000068>
- Valentine, E. & Stewart, G., 2015, *Enterprise business technology governance: Three competencies to build board digital leadership capability*, IEEE Computer Society, Kauai, Hawaii.
- Veldsman, D., 2017, 'Validating the psychological work immersion scale as a measure for predicting business performance', Doctoral thesis, University of South Africa, Pretoria.
- Veldsman, T.H., 2015, 'What I have learned about our dire need for a leadership miracle: Everyone an amazing leader', *Cognoscenti* 1, 1–5.
- Windt, B., Borgman, H. & Chintan, A., 2019, 'Understanding leadership challenges and responses in data-driven transformations', in *Proceedings of the 52nd Hawaii International Conference on System Sciences*, Grand Wailea, HI, pp. 4987–4996.
- Woodruffe, C., 1993, 'What is meant by a competency?', *Leadership & Organization Development Journal* 14(1), 29–36. <https://doi.org/10.1108/eb053651>
- Yaghmale, F., 2003, 'Content validity and its estimation', *Journal of Medical Education* 3(1), 25–27.
- Yukl, G., 2012, 'Effective leadership behavior: What we know and what questions need more attention', *Academy of Management Perspectives* 26(4), 66–85. <https://doi.org/10.5465/amp.2012.0088>