

A Measurement Scale for School Leadership Professional Development Needs for the Fourth Industrial Revolution



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ABSTRACT

Research has shown that school leaders must improve their knowledge and skills as the Fourth Industrial Revolution (4IR) dawns. Thus, the study validated a scale that could be adopted to assess school leaders' development needs in the 4IR. Specifically, this study estimated the instrument's validity, determined the number of factors underlining the scale, and established the reliability coefficient of the scale. A quantitative survey design was used. A systematic sampling was conducted to select 284 respondents from selected basic schools (public and private) in the Ibadan metropolis, Oyo State, Nigeria. A content validity ratio (CVR) and a content validity index (CVI) were calculated based on the judgments of the panelists. Using Ordinal, Omega, and Guttman Alpha approaches, statistical computing was done using R software (R Core Team, 2020) to determine the underlying factors of the scale items using exploratory factor analysis (EFA). A parallel analysis identified eight factors: school leaders' knowledge of 4IR attributes, leaders' technology needs, easy usage of basic technology applications, agility, information management and evaluation, communication expressiveness and collaboration, critical thinking and problem-solving, and creativity. Based on the results, the scale is valid for measuring the construct, showing good content and construct validity. Also, there was high internal consistency in all the approaches used. The scale is reliable and valid. The study recommends that school leaders, administrators, researchers, and other stakeholders adopt this scale to assess their skills development needs in the 4IR era. Hence, scholars could use the scale to conduct reliable studies in Nigeria and other Sub-Saharan African nations.

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Publication History

Received:
10th August, 2024
Accepted:
12th November, 2024
Published online:
19th December, 2024

Keywords: *Agility, Fourth Industrial Revolution, Leadership Development, School Leaders, 4IR Leadership Skills.*

INTRODUCTION

Leadership development needs (LDNs) play a vital role in advancing school leaders in the fourth industrial revolution (4IR) towards positive changes in school systems. With the arrival of the 4IR, the transformation of the school system necessitates school leaders to be trained and retrained. Climate revolution, excess consumption by certain populations, instabilities in governments, globalisation, inclusiveness, migration, and pandemics are just some of the combined factors that threaten the world's

existence.¹ The 4IR brought about changes in career and institutional development, which led to a rapid transformation of work in all walks of life. As a result, the economy shifted from a handcraft-based economy to a machine-based one.² To lead a sustainable system, leadership capacity must be improved in current and global changes.³ There is a gap between school leaders' skills needed in the digital learning environment and their regular professional development skills. An important component of school leadership is understanding how it impacts students' success and school accomplishments regardless of the situation.⁴ Leader development is imperative for any educational system to achieve its educational objectives, as leaders and knowledge are the main drivers of any institution in the changing world.

However, assessing the LDNs of school leaders for professional training programmes or research purposes requires a valid and reliable measuring scale. To answer research questions, the researcher uses a measuring scale to gather information from respondents. Measuring scales are an excellent way to collect data from many people over a short period.⁵ Therefore, a well-designed measuring scale is crucial to ensuring accurate data can be collected, interpreted, and generalised. Bad measuring scales can make the results unintelligible or, worse, result in erroneous conclusions.⁶ In the past, students and researchers struggled to find a tool for their research, which led to a self-made instrument with insufficient validation.⁷ Scholars can now conduct original and reliable LPN studies in Sub-Saharan Africa and Nigeria using this validated scientific process. In this study, the researchers developed a measurement scale for researchers in leadership and education to assess school leaders' leadership development needs in the context of 4IR. Hence, the scale construct and internal consistency were validated in this study.

In Sub-Saharan Africa, there are a variety of instruments that assess leaders' and educators' professional needs.⁸ In the context of 4IR, researchers in education do not appear to have validated and reliable instruments to assess school leaders' professional needs in Sub-Saharan Africa. Thus, this study was carried out to provide a validated and reliable scale for measuring basic school leaders' professional development needs in the context of the 4IR era.

In education, researchers do not take cultural context into account when adopting or adapting research instruments.⁹ There are scientific and ethical concerns about the validity of the questionnaires used by researchers in Sahara-Africa, where Nigeria is located.¹⁰ Therefore, the researchers observed that

¹ David Dixon, "Educational Leadership for Sustainability: 50 Shades of Green, and Much More," *FORUM* 64, no. 1(2022):82–93..

² Violeta Sima et al., "Influences of the Industry 4.0 Revolution on the Human Capital Development and Consumer Behavior: A Systematic Review," *Sustainability* 12, no. 10 (2020): 4035..

³ Louis W. Fry and Eleftheria Egel, "Global Leadership for Sustainability," *Sustainability (Switzerland)* 13, no. 11 (2021): 1–27; Steve Schein, "Ecological Worldviews: A Missing Perspective to Advance Global Sustainability Leadership," *Journal of Management for Global Sustainability* 3, no. 1 (2015): 1–24.

⁴ Gurr, *Overview on Leadership in Schools under Challenging Circumstances*. Sima et al., "Influences of the Industry 4.0 Revolution on the Human Capital Development and Consumer Behavior: A Systematic Review."

⁵ Michael Ornstein, "Designing a Questionnaire," *Malaysian Family Physician* 1, no. 1 (2006): 32–35; Hamed Taherdoost, "Designing a Questionnaire for a Research Paper: A Comprehensive Guide to Design and Develop an Effective Questionnaire," *Asian Journal of Managerial Science* 11, no. 1 (2022): 8–16.

⁶ Marni Ishak and Fauzi Hussin, "Predictive Validity Study of Sustainable Leadership for Learning Questionnaire," *International Journal of Instruction* 15, no. 2 (2022): 601–22; Robert F. DeVellis, "Scale Development : Theory and Applications," *Applied Social Research Methods* 26 (2012): 31; Margarita Knickenberg, Carmen L.A. Zurbriggen, and Susanne Schwab, "Validation of the Student Version of the Perceptions of Inclusion Questionnaire in Primary and Secondary Education Settings," *SAGE Open* 12, no. 1 (2022): 1–10; Taherdoost, "Designing a Questionnaire for a Research Paper: A Comprehensive Guide to Design and Develop an Effective Questionnaire."

⁷ Omotayo Adewwale Awodiji and Musa Adekunle Ayanwale, "Causal Modelling of Head Teachers' Leadership Behaviour and Administrative Effectiveness in Public Basic School: Validation of the Measurement Instrument," *Pertanika Journal of Social Sciences and Humanities* 31, no. 2 (2023): 855–83; Hadi Suwono et al., "The Development and Validation of an Instrument of Prospective Science Teachers' Perceptions of Scientific Literacy," *Eurasia Journal of Mathematics, Science and Technology Education* 18, no. 1 (2022).

⁸ Cynthia Blitz and Rebecca Schulman, "Measurement Instruments for Assessing the Performance of Professional Learning Communities," *National Center for Education Evaluation and Regional Assistance*, (2016): 1–72; Arnoud Evers, Karel Kreijns, and Béatrice Van der Heijden, "The Design and Validation of an Instrument to Measure Teachers' Professional Development at Work," *Studies in Continuing Education* 38, no. 2 (2016).

⁹ Pastori and Pagani, "Is Validation Always Valid? Cross-Cultural Complexities of Standard-Based Instruments Migrating out of Their Context"; M Herdman, J Fox-Rushby, and X Badia, "A Model of Equivalence in the Cultural Adaptation of HRQoL.Pdf," *Quality of Life Research* 7, no. 7 (1998): 323; Guillermo Bernal, María Jiménez-Chafey, and Melanie Rodríguez, "Cultural Adaptation of Treatments: A Resource for Considering Culture in Evidence-Based Practice," *Professional Psychology: Research and Practice* 40, no. 4 (2009): 361–68; Yang Wang and Zhendong Wu, "Adapting or Adopting? Critical Thinking Education in the East Asian Cultural Sphere: A Systematic Integrative Review," *Thinking Skills and Creativity* 49, no. February (2023): 101330; Awodiji and Ayanwale, "Causal Modelling of Head Teachers' Leadership Behaviour and Administrative Effectiveness in Public Basic School."

¹⁰ Olufemi Timothy Adigun, "Predicting the Feasibility of Data Collection for Disability-Related Research in Sub-Saharan Africa," *Social Sciences and Humanities Open* 10, no. April (2024): 100988, ht.

there was a shortage of questionnaires in Saharan Africa, causing the researchers to design their own instruments without adequate psychometric properties for research in education, leadership, management, and other related social sciences.¹¹ Studies have been conducted to advocate for leadership development to navigate through the 4IR and digital era without sufficient reports on the validity of the instruments used.¹² Against this background, the researchers were prompted to develop a valid and reliable tool that could identify the skills school leaders need to develop their leadership competencies in the era of 4IR.

The research questions that guided this study are as follows.

- What is the validity of the instrument?
- How many factors underline the scale?
- What is the reliability coefficient of the scale?

Concept of School Leaders' Leadership Development Needs

The role of leadership development in the changing era cannot be overemphasised. In a recent debate, it was revealed that continuous leadership development is vital for both the personal development of school leaders as well as their schools' collective success.¹³ School leaders require leadership development to be able to work in a variety of situations and handle challenging, complex, and unprecedented situations.¹⁴ The concept of LDN has been viewed from different theoretical and conceptual perspectives. Leadership development involves receiving expert advice and guidance in a personalised setting that addresses the needs of each school leader.¹⁵ Furthermore, LDN in an educational setting focuses on assessing and improving change vision, knowledge systems, and skills to improve the quality of school leadership.¹⁶ School leadership development needs may include workshops, training, and exchanges.¹⁷ LDNs refer to the specific skills, behaviours, and competencies that individuals or groups require to become effective leaders. It refers to areas where the school system identifies a need to improve the leadership skills or capabilities of school leaders. LDN recognises the multifaceted nature of school leadership responsibilities and the need for a collective framework to address the diverse expertise required.¹⁸ The LDN is an ongoing process that involves need assessment and continuous learning and improvement for school leaders to gain the appropriate skills and competencies for effective school leadership.¹⁹ LDNs

¹¹ Awodiji and Ayanwale, "Causal Modelling of Head Teachers' Leadership Behaviour and Administrative Effectiveness in Public Basic School.,"; DeVellis, "Scale Development: Theory and Applications"; Knickenberg, Zurbruggen, and Schwab, "Validation of the Student Version of the Perceptions of Inclusion Questionnaire in Primary and Secondary Education Settings."

¹² Tai Mei Kin et al., "Leading Sustainable Schools in the Era of Education 4.0: Identifying School Leadership Competencies in Malaysian Secondary Schools," *International Journal of Management in Education* 14, no. 6 (2020): 580–610; Oluwatoyin Ayodele Ajani, "Exploring the Teacher Professional Development in the Fourth Industrial Revolution: In Pursuit of Social Justice," *Journal of Research Innovation and Implications in Education* 5, no. 2 (2021): 101–9; Siboniso Mdluli and Olebile Makhupe, "Defining Leadership Competencies Needed for the Fourth Industrial Revolution: Leadership Competencies 4.0," *Duke CE*, 2017, 1–13.

¹³ Shun Wing Ng and Sing ying Elson Szeto, "Preparing School Leaders: The Professional Development Needs of Newly Appointed Principals," *Educational Management Administration and Leadership* 44, no. 4 (2016): 540–57; Jill M. Aldridge and Felicity I. McLure, "Preparing Schools for Educational Change: Barriers and Supports—A Systematic Literature Review," *Leadership and Policy in Schools* 00, no. 00 (2023): 1–26; Omotayo Adewale Awodiji and Suraiya Rathankoomar Naicker, "Preparing School Leaders for the Fourth Industrial Revolution: An Assessment of Their Continuous Professional Development Needs," *Social Sciences and Humanities Open* 8, no. 1 (2023): 100521; L Darling-Hammond et al., "Preparing School Leaders for a Changing World: Lessons from Exemplary Leadership Development Programs" (Stanford, CA, 2007).

¹⁴ Syed Bukhari et al., "The Role, Professional Development, and Challenges of Principals: Key Ingredients of School Leadership," *Pakistan Journal of Humanities and Social Sciences* 9, no. 2 (2021): 141–49.

¹⁵ Parker M Andreoli et al., "Learning to Lead School Improvement: An Analysis of Rural School Leadership Development," *Journal of Educational Change* 21, no. 0 (2020): 517–42.

¹⁶ Anna Zhukova, "The Concept of Leadership Development of Students," *Bulletin of Oleksandr Dovzhenko Hlukhiv National Pedagogical University* 51, no. 1 (2023): 195–200.

¹⁷ Ulrich Müller et al., "School Leadership, Education for Sustainable Development (ESD), and the Impact of the COVID-19 Pandemic: Perspectives of Principals in China, Germany, and the USA," *Education Sciences* 12, no. 12 (2022): 1–19, <https://doi.org/10.3390/educsci12120853>; Bich Khuyen Dinh Ngoc et al., "Academic Leadership Development: An Exploratory Study on the Impacts at the Institutional Level Based on an Erasmus+ Capacity Building Project," *SAGE Open* 13, no. 4 (2023): 1–19.

¹⁸ Angelique Skoulas and Elsbeth Kalenderian, "Leadership Training for Postdoctoral Dental Students," *Journal of Dental Education* 76, no. 9 (2012): 1156–66; Brandon Steinert, "Leadership Development Programs: Exploring the Real Impact upon Communities and Organizations" (Fort Hays State University, 2016).

¹⁹ Sue Dopson et al., "Leadership Development in Higher Education..." *Higher Education Quarterly* 73, no. 2 (2019): 218–34; Katrin Poom-Valickis, Eisenschmidt Eve, and Ann Leppiman, "Creating and Developing a Collaborative and Learning-Centred School Culture: Views of Estonian School Leaders," *Center for Educational Policy Studies Journal* 12, no. 2 (2022): 217–37; Raj Mestry, "Empowering Principals to Lead and Manage Public Schools Effectively in the 21st Century," *South African Journal of Education* 37, no. 1 (2017).

are designed initiatives developed to assess and upgrade school leaders' skills, abilities, and behaviours to empower them for leadership roles within school settings.²⁰ Through LDN, school leaders will understand and develop their ability to guide their teams, drive school success, and navigate challenges.²¹ Moreover, there is a gap between educators' needs for professional development in online education and the design elements of professional development.²² Therefore, it is expedient to identify skills needed and reskill school leaders with relevant skills that will enable them to discharge their leadership role in the 4IR context.

The Fourth Industrial Revolution (4IR) in School Leadership

The 4IR brought about changes in the domains of career and institutional development. With the advent of 4IR, the economy moved from being a handicraft-based economy to a machine-based economy.²³ A developing economy such as Africa is set to be disrupted by 4IR at numerous levels, including human, technological society, business operations, and education.²⁴ The 4IR is advancing at an exponential rate rather than linearly. In all countries, most businesses, including schools, are being disrupted. As a consequence, a significant amount of change is underway in production, management and governance.²⁵ The questions that require interrogation are as follows: How aware are school leaders of the 4IR? Which skills do they currently have, and which skills do they need to be equipped with to lead the school in 4IR? Therefore, assessing the various dimensions of 4IR leadership skills in educational settings is important to help school leaders meet modern educational challenges.

Twenty-first-century skills, being the forerunner for 4IR skills, refer to the competencies that are necessary for the workplace and for education today. To maintain high-quality education, school leaders must have 4IR skills; to ensure that their institutions remain responsive, innovative, and focused.²⁶ This includes digital skills, information skills, agility, critical-thinking skills, collaboration and communication skills, adaptability and flexibility skills, creative skills, and problem-solving skills.²⁷

School leaders need digital skills because of the growing integration of technology in education and the societal shift towards digitalisation.²⁸ School leaders in 4IR must understand and effectively use technology to enhance learning and administration.²⁹ School leaders should also be digitally skilled with

²⁰ S. Levin et al., "Elementary School Principals' Professional Learning: Current Status and Future Needs," *Learning Policy Institute: Research Brief*, 2020, 1–11; John Knights, Danielle Grant, and Greg Young, "Developing 21st Century Leaders, a Complete New Process We Call Them Transpersonal Leaders," *Journal of Work-Applied Management* 12, no. 1 (2020): 6–21.

²¹ Astérie Nyirahabimana and Phumzile Magagula, "Teachers and Head-Teachers Continuous Professional Development : Key Data Analysis for Quality Education Achievement in Sub- Saharan Africa," 2023.

²² Antigona Uka, Marigona Morina, and Eugene G Kowch, "Beyond Learning by Videoconference : Findings from a Capacity-Building Study of Kosovan Teachers in the Post-Covid-19 Era," *Center for Educational Policy Studies Journal*, no. April (2024).

²³ Serumaga-Zake and van der Poll, "Addressing the Impact of Fourth Industrial Revolution..."; Sima et al., "Influences of the Industry 4.0 Revolution on the Human Capital Development and Consumer Behavior: A Systematic Review."

²⁴ Serumaga-Zake and van der Poll, "Addressing the Impact of Fourth Industrial Revolution..."

²⁵ Klaus Schwab, "The Fourth Industrial Revolution: What It Means, How to Respond," *Economy, Culture & History Japan Spotlight Bimonthly*, 2016.

²⁶ Ntsebeng R. Letuma, Omotayo A. Awodiji, and Suraiya R. Naicker, "An Assessment of Leadership Development Needs of School Leaders for the 4.0," *Journal of Management and Business Education* 6, no. 3 (October 2023): 395–414.

²⁷ Ester van Laar et al., "Measuring the Levels of 21st-Century Digital Skills among Professionals Working within the Creative Industries: A Performance-Based Approach," *Poetics* 81 (2020): 101434; J Uys and R Webber-Youngman, "A 4.0D Leadership Model Postulation for the Fourth Industrial Revolution Relating to the South African Mining Industry," *The Journal of the Southern African Institute of Mining and Metallurgy* 119, no.10(2019): 793–800; Onoriode Potokri, "Positioning African Women for the Fourth Industrial Revolution (4IR) Era: Insights for Women Students," *Prizren Social Science Journal* 6, no. 1 (2022): 84–94; Virginia Naidoo and Collins Onoriode Potokri, "Female School Leaders and the Fourth Industrial Revolution in South Africa," *International Journal of Innovation, Creativity and Change*. 15, no. 10 (2021): 162–80; Awodiji and Naicker, "Preparing School Leaders for the Fourth Industrial Revolution..."; Mdluli and Makhube, "Defining Leadership Competencies Needed for the Fourth Industrial Revolution: Leadership Competencies 4.0."

²⁸ Mark E. Malone, "The Relationship of the Principal's soft Skills to School Climate" (The University of Texas at San Antonio, 2013); N. V. Komarova, A. Zamkovi, and S. V. Novikov, "The Fourth Industrial Revolution and Staff Development Strategy in Manufacturing," *Russian Engineering Research*, no. 4 (2019): 330–33; David Evertson, "The Influence of Principal Leadership on Teacher Collaboration: The Influence of Principal Leadership on Teacher Collaboration: Does Effective Professional Development Mediate This Effect? Does Effective Professional Development Mediate This Effect?" (University of Nebraska - Lincoln, 2020); Basak Baglama et al., "Analysis of Digital Leadership in School Management and Accessibility of Animation-Designed Game-Based Learning for Sustainability of Education for Children with Special Needs," *Sustainability* 14, no. 13 (2022): 1–12.

²⁹ Mai Nguyen et al., "Impact of Technology-Based Knowledge Sharing on Employee Outcomes: Moderation Effects of Training, Support and Leadership," *Journal of Knowledge Management* 27, no. 8 (2023): 2283–2301; Amnat Apsorn, Boonchan Sisan, and Pariyaporn Tungkunan, "Information and Communication Technology Leadership of School Administrators in Thailand.," *International Journal of Instruction* 12, no. 2 (2019): 639–50.

the advent of remote learning, online learning environments, and digital tools.³⁰ As a result, they will be able to protect student data and the school's digital infrastructure.

Furthermore, leaders need information management and evaluation skills to make informed decisions, streamline operations, and improve educational outcomes. Managing and evaluating information are essential skills for school leaders. Data-driven decisions enable leaders to allocate resources wisely, maintain accountability, improve performance, plan strategically, and manage crises.³¹ The ability to organise, respond, and maintain a thriving educational environment requires these skills.

In addition, agility capacity has been identified as a potential skill required to lead in a changing and challenging environment.³² Leading with agility is the key to success in every organisation.³³ Agile leaders can step back from their current focus, gain a broader perspective, and then refocus and take action based on that broader perspective.³⁴ A turbulent environment has followed in the wake of the COVID-19 pandemic, providing an opportunity for studying organisations' leadership agility and digital resilience.³⁵ Joiner observed that leaders of schools require four types of leadership agility to lead in changing times: context-setting agility, stakeholder agility, creative agility, and self-leadership agility.³⁶ According to Donovan and Leurent et al., the 4IR's changing leadership ecosystem consists of six attributes: responsibility and accountability, systems leadership, technology leadership, entrepreneurial leadership, shaping societies, and adaptive leadership.³⁷

In the current educational landscape, school leaders must be able to critically think to tackle complex challenges, make informed decisions, and lead effectively. To make sound decisions, leaders must evaluate a large volume of information, distinguishing between credible and unreliable sources.³⁸ Through critical thinking, leaders can analyse data, research, and feedback to make informed decisions that benefit the school community.³⁹ School leaders face several complex problems, including resource allocation, curriculum development, and student behaviour problems.⁴⁰ Leaders can use critical thinking skills to approach challenges systematically, evaluating multiple perspectives and potential outcomes. It is, therefore, crucial for school leaders to develop critical-thinking skills to effectively manage the complexities of modern education, ensure positive change, and ensure school success. Leaders need critical thinking and problem-solving skills to make sound decisions, solve problems effectively, and lead schools toward achieving their educational goals.⁴¹ School leaders' ability to think critically is imperative not only for addressing immediate challenges but also for growing professionally and personally.⁴² School leaders who think critically are more likely to seek out updated knowledge, reflect on their practices, and strive for improvement.

Building a cohesive and resilient school community requires strong collaboration and communication skills in an era of change. Collaboration skills allow leaders to mobilize their team's

³⁰ Awodiji and Naicker, "Preparing School Leaders for the Fourth Industrial Revolution.."

³¹ Mojgan Afshari et al., "School Leadership and Information Communication Technology," *Turkish Online Journal of Educational Technology* 7, no. 4 (2008): 82–91; Nor Ahmad Khamzah, Sarah Md. Sah, and Norhayati Hussin, "Information Management in Education," *International Journal of Academic Research in Business and Social Sciences* 7, no. 8 (2017).

³² Bill Joiner, "Leadership Agility: A Global Imperative" (Boston, Massachusetts, 2013).

³³ Joiner, "Leadership Agility: A Global Imperative"; American Management Association, "A Study of Leadership from 2005 through 2015 Agility and Resilience in the Face of Continuous Change a Global Study of Current Trends and Future Possibilities Canada USA-Latin America-Asia-Pacific Europe-Middle East-Africa," 2016.

³⁴ Joseph Mccann, "Building Agility, Resilience and Performance in Turbulent Environments," *People & Strategy* 32, no. 3 (2009): 45–51; Bill Joiner, "Leadership Agility for Organizational Agility," *Journal of Creating Value* 5, no. 2 (September 2019): 139–49.

³⁵ George Mangalaraj, Sridhar Nerur, and Rahul Dwivedi, "Digital Transformation for Agility and Resilience: An Exploratory Study," *Journal of Computer Information Systems* 63, no. 1 (2023): 1–3.

³⁶ Joiner, "Leadership Agility for Organizational Agility."

³⁷ Tara Donovan, "Leading through Challenging Situations," 2022.

³⁸ Peter P. Khaola and Francis A. Oni, "The Influence of School Principals' Leadership Behaviour and Act of Fairness on Innovative Work Behaviours amongst Teachers," *SA Journal of Human Resource Management* 18, no. 0 (2020): 1–8.

³⁹ Iordanoglou, "Future Trends in Leadership Development Practices and the Crucial Leadership Skills"; Heidari and Ebrahimi, "Examining the Relationship between Critical-Thinking Skills and Decision-Making Ability of Emergency Medicine Students"; Matarazzo and Pearlstein, "Leadership in Disruptive Times"; Kin et al., "Leading Sustainable Schools in the Era of Education 4.0."

⁴⁰ Omotayo Adewale Awodiji and Ancia Katjiteo, "A Systematic Review on the Fourth Industrial Revolution: African Basic Schools' Readiness," *Jurnal Bidang Pendidikan Dasar (JBPD)* 7, no. 2 (2023): 192–208.

⁴¹ Zahri Hamat et al., "Human Resources Development Model for the Industrial Revolution 4.0 Era in Aceh, Indonesia," *Turkish Journal of Computer and Mathematics Education* 12, no. 5 (2021): 44–55.

⁴² Dennis Zami Atibuni, Deborah Manyiraho, and Agnes Nabitula, "A Fourth Industrial Revolution Paradigm Shift in Teacher Education?," *International Journal of African Higher Education* 9, no. 2 (2022): 1–21.

collective strengths, foster innovation, and create a supportive and inclusive environment.⁴³ To navigate the complexities of change and achieve the school's vision and goals, communication skills are crucial.⁴⁴ Leaders need these skills to guide their schools through transitions, overcome challenges, and create a positive and forward-looking educational environment. The ability to effectively collect, analyse, and use data is becoming increasingly important for school leaders as the world changes.⁴⁵ School leaders can build dynamic, responsive and adaptive educational environments that adjust to changing needs and promote all students' success by leveraging these skills.

METHODOLOGY

Research Approach and Design

This study adopted a quantitative survey design because it allows a larger sample size and is statistically more powerful due to its large sample size.⁴⁶ Additionally, it provides a substantial amount of information on the school leadership development needs for the 4IR.

Population and Sample

The study targeted principals, vice-principals, head teachers, assistant head teachers, and heads of departments (HODs) in basic schools in 11 local governments of the Ibadan metropolis, Oyo State, Nigeria. A systematic sampling of the respondents was conducted in the Ibadan metropolis, Oyo State, Nigeria, from public and private schools.⁴⁷ Five local governments were selected at random.⁴⁸ Moreover, ten schools were conveniently selected from each of the five local government areas, for a total of 50 schools. The study schools were selected based on their accessibility, readiness, and acceptability. The snowball approach was used to select respondents based on school heads' referrals.⁴⁹ Four hundred copies of the questionnaire were distributed, and 284 were returned. During data cleaning, only 276 were used for validation, of these 102 (37%) were from males and 174 (63%) females.

Table 1: School Leaders' Demographic Data

Demographic Data	Frequencies	Percentage (%)
Gender		
Male	102	37.0
Female	174	63.0
Total	276	100.0
Age		
30 years and below	20	7.2
31-40 years	50	18.1
41-50 years	71	25.7
51 years – Above	135	48.9

⁴³ Kin et al., "Leading Sustainable Schools in the Era of Education 4.0"; Mukelabai M. Musheke and Jackson Phiri, "The Effects of Effective Communication on Organizational Performance Based on the Systems Theory," *Open Journal of Business and Management* 09, no. 02 (2021): 659–71; van Laar et al., "Measuring the Levels of 21st-Century Digital Skills among Professionals Working within the Creative Industries: A Performance-Based Approach."

⁴⁴ Sufean Hussin and Saleh Al Abri, "Professional Development Needs of School Principals in the Context of Educational Reform," *International Journal of Educational Administration and Policy Studies* 7, no. 4 (2015): 90–97.

⁴⁵ Nasiri Mehran, Shafiee Shahram, and Sepasi Hossein, "Relationship between Communication Skills and Effectiveness," *International Journal of Basic Sciences & Applied Research* 1, no. 4 (2012): 101–6.

⁴⁶ Outi Kanste, Jouko Miettunen, and Helvi Kyngäs, "Psychometric Properties of the Multifactor Leadership Questionnaire among Nurses," *Journal of Advanced Nursing* 57, no. 2 (2007): 201–12; Awodiji and Naicker, "Preparing School Leaders for the Fourth Industrial Revolution..."

⁴⁷ Anita S Acharya et al., "Sampling: Why and How of It," *Indian Journal of Medical Specialties* 4, no. 2 (2013): 330–33; Adeseko Sunday Olaifa and Omotayo Adewale Awodiji, "Nexus between Principals' Instructional Responsibilities and Secondary School Effectiveness," *International Journal of Theory and Application in Elementary and Secondary School Education* 5, no. 1 (2023): 63–77.

⁴⁸ R. S. Brown, "Sampling," in *International Encyclopedia of Education*, ed. P. Peterson, E. Baker, and B. McGaw, Third Edit (Oxford: Elsevier, 2010), 142–46; Roger Watson, "Quantitative Research," *Nursing Standard* 29, no. 31 (2015): 44–48.

⁴⁹ Chaim Noy, "Sampling Knowledge: The Hermeneutics of Snowball Sampling in Qualitative Research," *International Journal of Social Research Methodology* 11, no. 4 (2008): 327–44; Anne Gademmann, Martin Guhn, and Bruno Zumbo, "Estimating Ordinal Reliability for Likert-Type and Ordinal Item Estimating Ordinal Reliability for Likert-Type and Ordinal Item Response Data: A Conceptual, Empirical, and Practical Guide Response Data: A Conceptual, Empirical, and Practical Guide," *Practical Assessment, Research, and Evaluation* 17 (2012): 1–13; Acharya et al., "Sampling: Why and How of It."

Total	276	100.0
Year of Experiences		
1-5 years	133	48.2
6 – 10 years	61	22.1
11 years and above	82	29.7
Total	276	100.0
School Type (Ownership)		
Private	86	31.2
Public	190	68.8
Total	276	100.0
School Level		
Primary	53	19.2
Secondary	223	80.8
Total	276	100.0
Rank		
Principal	34	12.3
Vice/Deputy Principal	99	35.9
Headmaster/Mistress	18	6.5
Assistant Headmaster/Mistress	17	6.2
HOD	108	39.1
Total	276	100.0
Highest Qualifications		
NCE	29	10.5
Bachelor's degree	132	47.8
Master's degree	57	20.7
Post Graduate Degree in Education	50	18.1
PhD	8	2.9
Total	250	100.0

The demographic data shown in Table 1 represent the characteristics of school leaders of the Ibadan Metropolis of Oyo State who participated in the study. Most of these leaders are from public primary and secondary schools.

Data Collection Tools/instruments

In scientific study and research, instrumentation is the process of developing tools and instruments to collect data. Instrumental design aims to create reliable, valid, and accurate instruments.⁵⁰ Measurement instruments are designed and improved through the process of instrument design.⁵¹ Creating, testing, and validating items that measure school leadership development is a systematic process in creating a scale. Thus, the instrumental design was adopted.⁵² Using questionnaires, surveys, or other data collection methods involves gathering participants' perceptions or understanding of a phenomenon. Research

⁵⁰ D. Betsy McCoach, Robert K. Gable, and John P. Madura, *Instrument Development in the Affective Domain: School and Corporate Applications*, ed. D. Betsy McCoach, Robert K. Gable, and John P. Madura, *Instrument Development in the Affective Domain: School and Corporate Applications* (New York: Springer, 2013); Joyce Pittman and Tamilyn Bakas, "Measurement and Instrument Design," *Journal of Wound, Ostomy and Continence Nursing* 37, no. 6 (2010): 603–7.

⁵¹ Azim Azuan Osman, Norani Nordin, and Mohd Faizol Abd Rahman, "Measuring Lean Culture: Designing a Research Instrument," *Journal of Modern Manufacturing Systems and Technology* 5, no. 1 (2021): 7–17; Blitz and Schulman, "Measurement Instruments for Assessing the Performance of Professional Learning Communities."

⁵² Omotayo Adewale Awodiji et al., "Modelling Motivational Techniques with Teachers' Job Satisfaction in Private Secondary Schools," *International Journal of Theory and Application in Elementary and Secondary School Education (IJTAESE)* 4, no. 1 (2022): 22–42; Awodiji and Ayanwale, "Causal Modelling of Head Teachers' Leadership Behaviour and Administrative Effectiveness in Public Basic School: Validation of the Measurement Instrument"; Shafinaz A. Maulod et al., "Relationship between Principals' Emotional Intelligence and Instructional Leadership Practices in Malaysian Secondary Schools," *International Journal of Advanced And Applied Sciences* 4, no. 3 (March 2017): 122–29; McCoach, Gable, and Madura, *Instrum. Dev. Affect. Domain Sch. Corp. Appl.*

instruments are designed to ensure data validity and reliability by assessing face and construct validity.⁵³ Instrument validity and reliability must be maintained regardless of whether researchers modify existing instruments or combine different tools.⁵⁴ The design outlines how a researcher chooses to conduct his or her research. A valid and reliable measure of an attribute of interest was developed using a scale described in this study, School Leaders' Professional Development Needs for the 4IR Scale (SLPDN4S), with four sub-scales. These sub-scales are school leaders' knowledge of 4IR, technology needs, easy usage of basic technology applications, and 4IR school leaders' skills. An extensive literature review was conducted to identify relevant items and scales from existing studies to assess school leaders' 4IR skills needs (SLPDN4S). The items were extracted from Ester van Laar et al.⁵⁵ The instrument was divided into five sections, namely, participants' personal information, which comprised nine items. The second section is based on Leaders' knowledge of 4IR (SLK4) with nine attributes, namely, robotics, artificial intelligence, the Internet of Things, information and communication technology, smart boards, 3D printing, machine learning, and automation. The third section deals with Leaders' technology needs (LTNs) with four items. The fourth section deals with seven items concerning the easy use of basic technology applications (EUBTA). Lastly, the fifth section deals with 4IR leadership skills (4LS), which include seven identified skills: information management and evaluation, agility, collaboration, critical thinking, creativity, communication expressiveness, and problem-solving on a five-point Likert scales of 1=never, 2=rarely, 3=sometimes, 4=often, 5=always.

Data Analysis

Profiles of participant demographics were compiled descriptively. Using exploratory factor analysis (EFA) to reduce the number of scale items and determine their underlying factors, the researchers used R software for statistical computing.⁵⁶ The scale proposed 10 factors before subjecting the data to content validity, parallel analysis, and reliability. Parallel analysis suggests eight factors.

Ethical Considerations

Ethics approval was sought from the Research Ethics Committee of the University of Johannesburg with Ethical Clearance Number: Sem 2-2022-014. In addition, the researchers further sought permission from the selected school authorities in Nigeria to administer the questionnaire to school leaders. The questionnaires were administered with the consent of school leaders who participated voluntarily based on the selected school authorities' permission. Participants answered the questionnaires indicating their agreement or disagreement with each statement. The results of the survey were statistically analysed.

PRESENTATION OF FINDINGS

Content Validity

At the initial level, content validity was established. Content validity assesses how well test responses represent a behavioural sample and how well the test questions and scores are.⁵⁷ The panel comprised eight experts, including three from research, measurement, and evaluation. It also included one in education technology and psychology and four in educational leadership and management. They adjudged whether an item was "essential" or "non-essential" in terms of knowledge, needs, usage, and skills.⁵⁸ There were nine items on the knowledge of the 4IR attributes of school leaders (SLK4), four

⁵³ Frankie Santos Laanan, "Studying Transfer Students: Part I: Instrument Design and Implications," *Community College Journal of Research and Practice* 28, no. 4 (2004): 331–51.

⁵⁴ Laanan, "Studying Transfer Students: Part I: Instrument Design and Implications."

⁵⁵ Ester van Laar et al., "21st-Century Digital Skills Instrument Aimed at Working Professionals: Conceptual Development and Empirical Validation," *Telematics and Informatics* 35, no. 8 (2018): 2184–2200; Ester van Laar et al., "Determinants of 21st-Century Skills and 21st-Century Digital Skills for Workers: A Systematic Literature Review," *SAGE Open* 10, no. 1 (January 2020): 1–14; Talita Greyling et al., "Leading the Girl Child into the Fourth Industrial Revolution," n.d.

⁵⁶ R Core Team, "R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing," European Environment Agency, Vienna, Austria., 2020.

⁵⁷ Haradhan Mohajan and Haradhan Mohajan, "Two Criteria for Good Measurements in Research: Validity and Reliability," *Annals of Spiru Haret University* 17, no. 4 (2017): 56–82; Anne R. Fitzpatrick, "The Meaning of Content Validity," *Applied Psychological Measurement* 7, no. 1 (1983): 3–13; C. H. Lawshe, "A Quantitative Approach to Content Validity," *Personnel Psychology* 28, no. 4 (1975): 563–75.

⁵⁸ Lawshe, "A Quantitative Approach to Content Validity."

items on the technology needs of school leaders (LTNs), seven items on ease of use of basic technology applications (EUBTA), and 62 items on the skills of 4IR leadership (4LS). Positive as well as negative items are included on the scale. Psychophysical principles support the assumptions that any item which most panellists consider "essential" has some degree of content validity (CV). A greater percentage of the panellists (beyond 50%) feel that the item is "essential," the greater it's content validity.⁵⁹ The contents validity ratio (CVR) and content validity index (CVI) was determined based on panellists' judgements.

$$CVR = \frac{ne - \frac{N}{2}}{\frac{N}{2}}$$

Ne= Number of Panellists indicated items as essential

N= Total Number of Panellists

CVI = Total Sum of CVR retained/Total number of Items retained (Lawshe, 1975).

Thus, the CVR was estimated for SLK4, of nine items generated, seven were deemed essential, four items of LTN were considered essential, nine items of EUBTA were retained, while 52 items of 4LS were considered essential out of 62 items deemed essential with CVR ranges (0.75 and 1.00) (Lawshe, 1975). Moreover, the CVI was found to be 0.93, 0.95, 0.82, and 0.88, which are highly valid values (Lawshe, 1975). The items of school leaders' knowledge of 4IR attributes (SLK4) consisted of statements in which respondents rated their knowledge, using a 4-point Likert scale: ('1= not at all', '2= some extent', '3= large extent', '4= large extent'). Also, items of LTNs with a 4-point Likert scale ('1= not at all', '2= some extent', '3= large extent', '4= large extent'), while items of EUBTA with a 5-point Likert scale ('1= I cannot do this', '2= difficult', '3= moderate', '4= easy', '5= very easy'). The 52 items of the 4IR leadership skills (4LS) again used a five-point Likert scale ('1=never', '2=rarely', '3=sometimes', '4=often', '5= always').

Construct Validity

To determine construct validity, it is necessary to examine the relationship between responses to test items.⁶⁰ That demonstrates how precisely a measuring scale measures theoretical psychological features. Determining the associated abstract factor is grounded on the conversion of the construct into a tangible, noticeable entity through observable behaviours.⁶¹ A parallel analysis approach was used to establish the factors for the scale.⁶² Before undertaking a parallel analysis, the scale proposed ten factors adapted from existing literature.⁶³ According to a parallel analysis, eight factors were loaded. However, neither item 1 nor item 30 was loaded under any factor. In total, 63 items were loaded under eight factors. These two items were eliminated because they were redundant and were not loaded under any factor suggested.⁶⁴ The scree plot is displayed in Figure 1:

⁵⁹ Lawshe, "A Quantitative Approach to Content Validity."

⁶⁰ Ömay Çokluk and Duygu Koçak, "Using Horn's Parallel Analysis Method in Exploratory Factor Analysis for Determining the Number of Factors," *Kuram ve Uygulamada Eğitim Bilimleri* 16, no. 2 (2016): 537–52.

⁶¹ Valiolah Farzad, Saideh Pirhosinloo, and Mansureh Shahriari Ahmadi, "Psychometric Properties of the Teachers' Achievement Goals in Work Questionnaire (TAGWQ): Factor Structure, Validity and Reliability," *Journal of Applied Psychology* 16, no. 1 (March 2022): 92–71; Çokluk and Koçak, "Using Horn's Parallel Analysis Method in Exploratory Factor Analysis for Determining the Number of Factors"; Mohajan and Mohajan, "Two Criteria for Good Measurements in Research: Validity and Reliability."

⁶² Çokluk and Koçak, "Using Horn's Parallel Analysis Method in Exploratory Factor Analysis for Determining the Number of Factors."

⁶³ Edona Berisha Kida and Theodhori Karaj, "Development of an Albanian Version of the Questionnaire on Teacher-Student Interaction," *Center for Educational Policy Studies Journal* 10, no. 3 (2020): 145–69.

⁶⁴ Theodoros A. Kyriazos and Anastasios Stalikas, "Applied Psychometrics: The Steps of Scale Development and Standardisation Process," *Psychology* 9, no. 11 (October 2018): 2531–60; Jingying Liu et al., "The Use of Career Growth Scale in Chinese Nurses: Validity and Reliability," *International Journal of Nursing Sciences* 2, no. 1 (2015): 80–85.

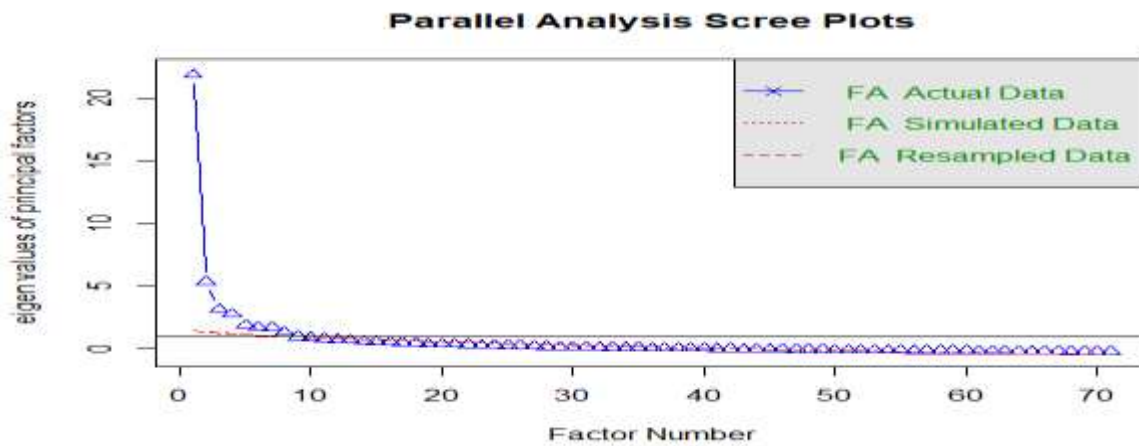


Figure 1: Parallel Scree Plots on School Leaders’ Professional Needs

Based on Figure 1, the eight factors loaded are Knowledge of 4IR attributes, Easy use of basic technology applications, technology training needs, agility, information management and evaluation, communication expressiveness and collaboration, critical thinking and problem-solving, and creativity. The first factor ‘School leaders’ knowledge of 4IR attributes’ (SLK4) loaded with six items (TECHKN1, TECHKN2, TECHKN3, TECHKN4, TECHKN5, and TECHKN6) as shown in Table 2.

Table 2: School leaders’ knowledge of 4IR attributes

S/N	Items	1	2	3	4
TECHKN1	3D printing				
TECHKN2	Internet of Things				
TECHKN3	Artificial intelligence				
TECHKN4	Information and communication technology.				
TECHKN5	Automation				
TECHKN6	Smart Board				

In Table 3, ‘Leaders’ technology needs’ (LTNs) are loaded with four items (TECHND1, TECHND2, TECHND3, and TECHND4).

Table 3: School Leaders’ Technology Needs

SN	I NEED.....	YES	NO	MAYBE	SOMEWHAT
TECHND1	to learn how to use applications				
TECHND2	training on how to use technology				
TECHND3	faster access to the internet				
TECHND4	training on the 4IR new technologies				

In Table 4, ‘Easy usage of basic technology applications’ (EUBTA) loaded with seven items (EoU1, EoU2, EoU3, EoU4, EoU5, EoU6, and EoU7).

Table 4: Easy use of basic technology applications by school leaders

SN	HOW EASY IS IT FOR YOU TO	Very easy	Easy	Moderate	Difficult	I cannot do this
EoU1	send an email?					
EoU2	attach a printer to a computer?					
EoU3	create a spreadsheet?					
EoU4	edit a photo?					
EoU5	download and/ or install software/apps?					

EoU6	use web tools to receive online information (RSS feeds, Google+, LinkedIn, Twitter feeds, etc.)?					
EoU7	surf the internet to gather information?					

The ‘4IR leadership skills’ (4LS) with 46 items were loaded under five factors (Agility, Information management and evaluation, Communication expressiveness and Collaboration, Critical thinking and Problem-solving, and Creativity) as shown in Table 5. Under the 4LS, seven constructs were proposed with 52 items. However, items proposed for communication expressiveness and collaboration were loaded under a single factor while items meant for critical thinking and problem-solving were loaded under one factor. Six items are not loaded under any factor. Thus, these measures were joined together to form a construct.⁶⁵

Table 5: 4IR leadership skills

i.	Agility: How often	1	2	3	4	5
1	do you continuously seek out new challenges?					
2	do you actively seek feedback from others to grow and develop?					
3	do you tend to self-reflect?					
4	do you evaluate your experiences and draw practical conclusions?					
ii.	Information management and evaluation: How often do you					
5	get what you want from interactions on the internet					
6	accomplish your task effectively using the computer					
7	know how to use platforms such as Zoom, Google Meet, MS Teams, etc to express ideas clearly					
8	post a blog/article on the internet/social media					
9	post new messages on the social media platforms for staff and students					
10	share information on the social media to initiate a discussion					
11	establish online contacts to collaborate with					
12	find experts on the internet to start a project with					
13	spend time and effort in online networking with people from your field					
14	use online network to generate ideas and opportunities for self and school development					
15	build online relationships with people from your field					
16	find the internet helpful when approaching new professional contacts					
17	start a conversation with other professionals via the internet					
18	use your online network to achieve policy					
iii.	Communication expressiveness and Collaboration: Do you:					
19	share important information with your team via electronic/social media platforms?					
20	use the internet to share resources that help the team perform tasks?					
21	engage new collaborations by approaching online contacts?					
22	find that electronic/social media platforms help you get support from co-workers?					
23	communicate via the internet with co-workers from other disciplines?					

⁶⁵ James C. Hayton, David G. Allen, and Vida Scarpello, “Factor Retention Decisions in Exploratory Factor Analysis: A Tutorial on Parallel Analysis,” *Organizational Research Methods* 7, no. 2 (2004): 191–205.; Çokluk and Koçak, “Using Horn’s Parallel Analysis Method...”

24	share work-related knowledge with other principals via the internet?					
25	use the internet to give feedback to co-workers?					
26	find the internet helpful to utilise other professionals' expertise?					
iv.	Critical thinking/ Problem Solving: Do you					
27	use the contribution of ideas from collaborators					
	to give substantiated arguments or reasoning?					
28	give proof or examples of arguments you give?					
29	pay attention to each teacher/student individually?					
30	present the discussion from a new perspective?					
31	ask questions to understand other people's viewpoint?					
32	consider various arguments to formulate your own point of view?					
33	connect viewpoints to give a new turn to the discussion?					
34	filter the most important points from discussions?					
35	suggest new related points to issues?					
36	find that electronic/social media platforms assist you to find the best way to solve the problem?					
37	come up with solutions to the problem via the electronic/social media platforms?					
38	find that when you are confronted with a problem that you have confidence in using the internet to solve the problem?					
39	make a decision using the internet that makes you feel happy afterwards?					
v.	Creativity Do you:					
40	give a creative turn to existing processes using the electronic/social media platforms?					
41	use the electronic/social media platforms to generate innovative ideas for your field?					
42	show originality in your work using the electronic/social media platforms?					
43	use the electronic/social media platforms to execute your tasks creatively?					
44	follow trends on electronic/social media platforms to generate original ideas?					
45	use electronic/social media platforms to evaluate the usability of your ideas?					
46	harness skills, talents, and potential for the workplace?					

Reliability

Essentially, reliability refers to the degree to which measurements can be repeated, that is, the ratio between true variances and true variances plus error variances.⁶⁶ The reliability of the results is the ratio of variance (V) in the observed scores O as a function of variance (T) in the original scores: $V(T)/V(O)$.⁶⁷ Ordinal data is regarded as a type of data set that has an inherent order and can be given any value. It is impossible to interpret the values, differences, or ratios between ordinal data.⁶⁸ An ordinal scale is a discrete-valued variable with discrete or "separated" values.⁶⁹ Thus, since the data set used for the study

⁶⁶ Terry K. Koo and Mae Y. Li, "A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research," *Journal of Chiropractic Medicine* 15, no. 2 (June 2016): 155; Fabiane F.R. Morgado et al., "Scale Development: Ten Main Limitations and Recommendations to Improve Future Research Practices," *Psicologia: Reflexao e Critica* 30, no. 1 (2017): 1–20.

⁶⁷ Andrew F. Hayes and Jacob J. Coutts, "Use Omega Rather than Cronbach's Alpha for Estimating Reliability. But...", *Communication Methods and Measures* 14, no. 1 (2020): 1–24; Italo Trizano-Hermosilla and Jesús M. Alvarado, "Best Alternatives to Cronbach's Alpha Reliability in Realistic Conditions: Congeneric and Asymmetrical Measurements," *Frontiers in Psychology* 7, (2016): 769.

⁶⁸ Yingruolan Li, "Confirmatory Factor Analysis with Continuous and Ordinal Data: An Empirical Study of Stress Level" (Uppsala University, 2014).

⁶⁹ Harry Khamis, "Measures of Association How to Choose?," *Journal of Diagnostic Medical Sonography* 24, no. 3 (2008): 155–162.

is an inherent order, the scale's reliability was determined using Ordinal Alpha, Guttman Method and Omega Alpha.⁷⁰ Studies have shown the weaknesses of Cronbach alpha, especially for ordinal data which suggested the use of ordinal, Omega and Guttman alpha.⁷¹ Moreover, in the case of binary or ordinal data, like Likert-type or mixed items, with 2 to 7 response options, a polychoric correlation-based reliability coefficient, such as alpha or omega, has been recommended.⁷²

Table 2 shows the reliability coefficient of the scale and its factors. The scale's internal consistency was validated using these three approaches.

Table 2: Reliability Coefficient of the Scale and its Factors

Scales	Ordinal Alpha (Rho)	Guttman Alpha (Rho)	Omega Alpha (Rho)
School Leaders' Professional Development Needs' for 4IR Scale (SLPDN4S)	0.97	0.97	0.97
School leaders' knowledge of 4IR (SLK4)	0.86	0.86	0.86
Leaders' technology needs (LTNs)	0.92	0.92	0.92
Easy usage of basic technology applications (EUBTA)	0.89	0.89	0.89
School Leaders' Fourth Industrial Revolution Skills (4LS)	0.97	0.97	0.97
Agility (AGS)	0.84	0.84	0.84
Information management and evaluation (IME)	0.92	0.92	0.92
Communication expressiveness and Collaboration (CECS)	0.96	0.96	0.96
Critical thinking and Problem solving (CTPS)	0.96	0.96	0.96
Creativity (CRT)	0.93	0.93	0.93

The whole 'School Leaders' Professional Development Needs' for the 4IR Scale (SLPDN4S) is divided into four sections with the fourth section focused on the 4IR school leadership skills with four factors and 52 items. The SLPDN4S indicated (0.97 coefficient) in all the approaches. The same applies to all the subscales and construct of the scale with Alpha values above 0.70.⁷³ As a result, the scale is highly consistent. This implies that the scale is fit to assess the school leadership skills needed in the 4IR consistently.

⁷⁰ C. Viladrich, A. Angulo-Brunet, and E. Doval, "A Journey around Alpha and Omega to Estimate Internal Consistency Reliability | Un Viaje Alrededor de Alfa y Omega Para Estimar La Fiabilidad de Consistencia Interna," *Anales de Psicología* 33, no. 3 (2017): 755–82; Maryam Davoodvandi, Shokouh Navabi Nejad, and Valiollah Farzad, "Examining the Effectiveness of Gottman Couple Therapy on Improving Marital Adjustment and Couples' Intimacy," *Iranian Journal of Psychiatry* 13, no. 2 (2018): 135; M. Shirdel et al., "Estimating the Validity and Reliability of Gottman Questionnaires of 'Couple Trust Measurement,'" *Contemporary Family Therapy* 41, no. 1 (March 2019): 37–46; Gadermann, Guhn, and Zumbo, "Estimating Ordinal Reliability for Likert-Type and Ordinal Item Estimating Ordinal Reliability for Likert-Type and Ordinal Item Response Data: A Conceptual, Empirical, and Practical Guide Response Data: A Conceptual, Empirical, and Practical Guide"; Trizano-Hermosilla and Alvarado, "Best Alternatives to Cronbach's Alpha Reliability in Realistic Conditions: Congeneric and Asymmetrical Measurements."

⁷¹ Hayes and Coutts, "Use Omega Rather than Cronbach's Alpha for Estimating Reliability. But..."; Trizano-Hermosilla and Alvarado, "Best Alternatives to Cronbach's Alpha Reliability in Realistic Conditions: Congeneric and Asymmetrical Measurements"; Viladrich, Angulo-Brunet, and Doval, "A Journey around Alpha and Omega to Estimate Internal Consistency Reliability."

⁷² Gadermann, Guhn, and Zumbo, "Estimating Ordinal Reliability for Likert-Type and Ordinal Item Estimating Ordinal Reliability for Likert-Type and Ordinal Item Response Data: A Conceptual, Empirical, and Practical Guide Response Data: A Conceptual, Empirical, and Practical Guide."

⁷³ Julie Pallant, *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS, Automotive Industries AI*, 4th editio, vol. 181 (Australia: Allen & Unwin, 2011).

DISCUSSION OF FINDINGS

Due to the Industrial Revolution, career and institutional development changed dramatically, resulting in a rapid transformation of work in every field. Therefore, the economy switched from a handcrafted economy to a machine-based economy.⁷⁴ Under current and global changes, school leaders must improve their leadership capacity.⁷⁵ School leadership involves understanding how leadership impacts student success and school achievements regardless of circumstance.⁷⁶ To actually bring about positive changes in school systems, LDN is crucial for school leaders in the 4IR. School leaders who will drive education activities in the 4IR era must be trained and re-skilled to accomplish the goal of basic education. A key component of the 4IR era is the development of educational leadership.

The objective of the study was to validate an instrument to identify school leaders' professional development needs during the 4IR. The objective was to develop a scale for the LDN of school leaders in Nigeria and subsequently other nations in Africa. A critical review of the literature on 4IR attributes and leadership skills led to the development of this scale. Following the development of the first survey instrument, the validity and reliability of the latent constructs and the corresponding items were tested in three phases. The first step consisted of content validity. Experts who formed panellists were requested to evaluate each item based on the "essentiality" and "non-essentiality". The CVR and CVI were derived based on the Lawshe, 1975 model from the panellists' responses. Based on the results, out of the 84 items subjected to CV, 72 items were retained as essential while 12 items were eliminated.⁷⁷

As part of the second stage, 4IR skills needs were surveyed to identify the factors/constructs that made up the scale. The survey gathered was subjected to Exploratory Factor Analysis (EFA) (parallel analysis) to explore the leadership factors loading of the items. From the ten proposed factors, eight factors are loaded. Items that were not loaded under any factors were removed while those loaded under single factors were merged. For instance, items under communication expressiveness and collaboration were merged to make a single factor as suggested by parallel loading while items meant for critical thinking and problem-solving formed a single factor. When deciding on the number of factors to retain, recommended to consider three reasons.⁷⁸ Choosing factor retention may have a greater impact than other related decisions (such as the choice of factor analytic method or rotation method) because factor retention decisions seem robust across options.⁷⁹ To balance parsimony and the underlying correlations, EFA must differentiate major factors from minor factors. Either specifying too few factors or specifying too many factors is known to cause significant errors. However, specifying too few is traditionally viewed as the most dangerous. SLPDN4S showed a 0.97 coefficient of reliability across all approaches. Similarly, Alpha values above 0.70 are found in all the subscales and constructs of the scale.⁸⁰ Thus, the scale is highly consistent.⁸¹ Thus, the scale can consistently evaluate the school leadership skills necessary for the 4IR.

RECOMMENDATIONS

Based on the findings of this study, it is recommended that the scales be applied in research relating to general or large populations in Africa and globally. Moreover, government, private individuals, school administrators, researchers, and other stakeholders to assess school leaders' continuous professional development needs in the 4IR era could adopt it. Lastly, it could serve as a guide in the organisation of leadership development for school leaders on types of 4IR skills to equip school leaders within the changing world.

⁷⁴ Sima et al., "Influences of the Industry 4.0 Revolution on the Human Capital Development and Consumer Behavior: A Systematic Review."

⁷⁵ Fry and Egel, "Global Leadership for Sustainability"; Schein, "Ecological Worldviews: A Missing Perspective to Advance Global Sustainability Leadership."

⁷⁶ Gurr, *Overview on Leadership in Schools under Challenging Circumstances*.

⁷⁷ Kida and Karaj, "Development of an Albanian Version of the Questionnaire on Teacher-Student Interaction."

⁷⁸ Hayton, Allen, and Scarpello, "Factor Retention Decisions in Exploratory Factor Analysis: A Tutorial on Parallel Analysis."

⁷⁹ Hayton, Allen, and Scarpello, "Factor Retention Decisions in Exploratory Factor Analysis: A Tutorial on Parallel Analysis."

⁸⁰ Pallant, *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS*.

⁸¹ Bright Mahembe and Amos S. Engelbrecht, "A Confirmatory Factor Analytical Study of a Servant Leadership Measure in South Africa," *SA Journal of Industrial Psychology* 39, no.2 SPL(2013); Morgado et al., "Scale Development: Ten Main Limitations and Recommendations to Improve Future Research Practices."

CONCLUSION

This study has provided a validated and reliable scale to measure basic school leaders' skills needs in the context of the 4IR era. This study has contributed to the research gap on the need for a validated scale to evaluate school leaders' skills needs in Sub-Saharan African nations. It has adequate psychometric properties for education, leadership, management, and other related social sciences research. At the end of the study, factors were examined using the Ordinal, Omega, and Guttman Alpha approaches. All the approaches used indicated a high level of internal consistency. The reliability and validity of the scales have been adjudged as good.

STUDY LIMITATIONS

Despite its merits, this research has some limitations. In this study, data were collected from school leaders from private and public schools in the Ibadan metropolis of Oyo State, Nigeria. Further, it may be critical in the future to survey a larger population to determine whether the same factor structures are observed with school leaders from other regions of Nigeria and Africa. The participants in this study were Nigerian school leaders (Principals, deputy/vice principals, Headmasters/deputies, and Heads of departments). Researchers from different countries are therefore encouraged to verify the instrument in various cultural contexts. Confirmatory Factor Analysis (CFA) and Exploratory Factor Analysis (EFA) will be required to verify the factor structure of an observed and latent variable set as well as its underlying factor structure. Lastly, it is important to examine the validity of this study in a variety of educational contexts.

FUNDING: The researchers declare that no funding was received from any individual or group of individuals for this study.

ACKNOWLEDGMENTS: The researchers thank all schools and participants who participated in this study for their support. Also, gratitude goes to the authors whose work were used in the study. Lastly, all experts who provided their expertise in the validation process are appreciated.

CONFLICTS OF INTEREST: As far as the authors know, they have no competing financial interests or personal relationships that could have influenced their work.

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