*engineering proceedings*

MDPI

*Proceeding Paper*

# A Data-Driven Architecture for Digital Capability Analytics and Readiness Assessment in Technology-Enhanced Educational Systems †

**Ritchfildjay L. Mariscal *, Dave Francis F. Bonso, James M. Bulaga and Jericho I. Gudito**

College of Industrial Technology and Teacher Education, Caraga State University, Cabadbaran 8605, Philippines; davefrancis.bonso@csucc.edu.ph (D.F.F.B.); james.bulaga@csucc.edu.ph (J.M.B.); jericho.gudito@csucc.edu.ph (J.I.G.)

* Correspondence: rlmariscal@carsu.edu.ph; Tel.: +63-9291554677

† Presented at the 8th International Global Conference Series on ICT Integration in Technical Education & Smart Society, Aizuwakamatsu City, Japan, 20–26 January 2026.

## Abstract

The rapid digital transformation of education has increased the demand for intelligent assessment systems and architecture capable of evaluating institutional readiness for technology-enhanced teaching, learning, and workforce development. As educational organizations adopt digital platforms, cloud-based learning environments, and globally connected instructional models, there is a growing need for systematic frameworks that can assess human, technological, and organizational capabilities required for successful implementation. This study proposes a digital capability assessment framework for technology-enhanced educational systems that integrates instructional competency evaluation, technology readiness analysis, infrastructure assessment, and institutional support monitoring within a unified analytics-driven model. The proposed framework consists of multiple assessment components, including digital literacy measurement, technology integration capability analysis, instructional innovation indicators, collaborative learning readiness metrics, and institutional resource evaluation mechanisms. These components are designed to support continuous monitoring of digital transformation initiatives and provide evidence-based decision support for educational planning, resource allocation, and technology adoption strategies. The framework further incorporates analytics and reporting functions that enable stakeholders to identify capability gaps, evaluate implementation risks, and prioritize system improvement initiatives. To demonstrate the applicability of the framework, a pilot assessment was conducted using competency and readiness data collected from instructional personnel within a technology-enhanced educational environment. Analytical results revealed strong capability levels across digital instructional practices, technology-supported curriculum development, online learning delivery, and collaborative knowledge-sharing activities. The assessment also identified infrastructure and support-related constraints that may affect the scalability and sustainability of advanced digital learning initiatives. The proposed framework contributes a scalable architecture for institutional readiness assessment and digital capability analytics within technology-enhanced educational systems. By integrating human capability indicators, infrastructure readiness measures, and organizational support metrics into a unified evaluation model, the framework provides a foundation for intelligent decision-support systems, digital transformation monitoring platforms, and technology governance mechanisms in modern educational ecosystems.

Check for updates

Academic Editors: Debopriyo Roy, George Fragulis and Peter Ilic

Published: 10 August 2026

**Copyright:** © 2026 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

**Keywords:** digital transformation readiness; digital instructional competence; technology integration; technology-enhanced learning; vocational education systems

## 1. Introduction

The increasing complexity of technology-enhanced educational systems requires assessment approaches that go beyond isolated measures of digital access, platform use, or user participation. These systems operate as sociotechnical environments composed of users, digital platforms, data resources, infrastructure, institutional processes, and support mechanisms. As a result, digital readiness must be examined through an architecture that captures the interaction among human capability, system quality, resource availability, technical support, and institutional conditions. This study proposes a data-driven architecture for digital capability analytics and readiness assessment in technology-enhanced educational systems. The architecture is designed to organize readiness indicators into measurable components, process capability-related data, identify implementation gaps, and generate evidence for decision-making. Its conceptual structure is informed by established information systems and technology acceptance models. The DeLone and McLean Information Systems Success Model identifies system quality, information quality, service quality, system use, user satisfaction, and net benefits as key dimensions for evaluating information system effectiveness [1]. These dimensions support the assessment of whether digital systems provide accessible, usable, reliable, and useful services to institutional users. Technology acceptance theories also provide constructs for designing readiness indicators. The Technology Acceptance Model explains how perceived usefulness and perceived ease of use influence user acceptance of information technology [2], while the Unified Theory of Acceptance and Use of Technology identifies performance expectancy, effort expectancy, social influence, and facilitating conditions as factors affecting technology use [3]. In the proposed architecture, these constructs are translated into indicators related to user preparedness, perceived system usefulness, ease of interaction, support availability, and enabling institutional conditions. This framing allows readiness to be treated as a technical, behavioral, and organizational construct. Digital capability is another core component of the proposed architecture. It refers to the capacity of users and institutions to access, evaluate, manage, create, communicate, and apply digital technologies in task-oriented and system-supported environments. Digital competence frameworks emphasize information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving as essential dimensions of digital participation [4]. In educational organizations, these dimensions can be converted into analytics indicators that describe how users engage with learning platforms, productivity tools, communication systems, digital resources, online assessment mechanisms, and emerging technologies. The proposed architecture integrates these theoretical dimensions into a unified readiness assessment model composed of five interrelated layers: input indicators, data collection, analytics processing, readiness interpretation, and decision-support reporting. The input layer captures indicators on digital literacy, technology integration capability, instructional innovation, infrastructure availability, system access, technical support, and institutional support. The data collection layer organizes these indicators into measurable survey items or institutional records. The analytics layer processes the data to determine capability levels, readiness patterns, and implementation constraints. The interpretation layer classifies strengths, gaps, and risks, while the reporting layer generates information for planning, resource allocation, capacity-building, and technology governance. Although previous studies have examined digital skills, technology adoption, and information system success separately,

https://doi.org/10.3390/engproc2026143057

fewer studies have integrated these dimensions into a single data-driven architecture for institutional readiness assessment. This gap is important because fragmented readiness data may limit the ability of institutions to identify capability gaps, prioritize interventions, and monitor digital transformation over time. Thus, this study develops and pilot-tests a data-driven architecture for digital capability analytics and readiness assessment. Specifically, it examines how user competence, technology integration capability, system accessibility, resource availability, technical support, and institutional support can be organized into an analytics-based readiness model. The contribution of the study lies in providing a scalable architecture that supports digital capability assessment, readiness monitoring, and evidence-based decision-making for technology-enhanced educational systems.

## 2. Methodology

### *2.1. Research Design*

This study employed a quantitative descriptive research design to develop and pilot-test a data-driven architecture for digital capability analytics and readiness assessment in a technology-enhanced educational system. The design was appropriate because the study aimed to describe and quantify readiness indicators related to user capability, technology integration, resource availability, institutional support, and system-level implementation conditions. Digital readiness was treated as a multidimensional construct involving human, technological, and organizational components. In the proposed architecture, these components were organized into measurable indicators and analyzed descriptively to generate evidence on capability levels, readiness patterns, and implementation constraints. The design therefore supported both empirical assessment and architectural modeling.

### *2.2. Participants and Sampling Procedure*

The participants were 45 technology education personnel from Caraga State University Cabadbaran Campus who were directly involved in technology-related, technical–vocational, laboratory-based, workshop-based, or skills-oriented instructional operations. They represented program areas such as Architectural Drafting; Automotive Technology; Civil and Construction Technology; Electrical Technology; Electronics Technology; Food Service Management; Garments, Fashion, and Design; and Welding Fabrication Technology. Purposive sampling was used because the study required respondents with direct exposure to technology-enhanced instructional environments and skills-based operations. The inclusion criteria covered personnel engaged in technology-related courses, laboratory or workshop activities, blended or digital instructional practices, digital resource use, or technical skills development during data collection. Personnel not directly involved in these functions were excluded. The sample was appropriate for the pilot assessment because the respondents represented target system users whose experiences were relevant to digital capability, technology access, infrastructure readiness, support availability, and institutional implementation conditions.

### *2.3. Research Instrument*

The study used an adapted structured questionnaire designed to collect readiness data for the proposed architecture. The instrument was developed from literature and previously validated tools related to technology adoption, digital literacy, instructional technology integration, information systems readiness, and technology-supported institutional operations. It was aligned with technology acceptance, digital capability, and information systems perspectives, particularly in relation to user competence, perceived system usability, facilitating conditions, resource adequacy, technical support, and institutional readiness. The questionnaire was modified to fit the institutional context of the

Caraga State University Cabadbaran Campus and the technology-oriented assignments of the participants. It consisted of seven parts: demographic and professional profile; digital capability and technology-enhanced instructional competence; training exposure and application of digital competencies; instructional resources and institutional support; implementation challenges; perceived effectiveness of technology-enhanced practices; and open-ended questions on strategies, support needs, system limitations, and recommendations. Most items used a five-point Likert scale to measure agreement, competence, readiness, perception, or availability of support. Open-ended items provided contextual explanations of implementation barriers, infrastructure limitations, support needs, and recommendations for system improvement. For architectural alignment, the questionnaire items were mapped into six readiness domains: human digital capability, technology integration capability, digital resource and infrastructure readiness, institutional and technical support, implementation barriers, and perceived system effectiveness. These domains served as the input layer of the proposed architecture. To ensure content validity, the instrument was reviewed by experts in technology education, educational technology, digital systems, and research instrumentation. The review focused on clarity, relevance, alignment with the proposed architecture, appropriateness of indicators, and contextual suitability. Revisions were made based on expert feedback. Reliability was established through pilot testing using Cronbach's alpha, with coefficients ranging from 0.835 to 0.963, indicating high to very high internal consistency.

### *2.4. Data Collection Procedure*

Prior to data collection, the researchers secured permission from the appropriate campus authorities and academic unit. After approval, prospective participants were informed about the study's purpose, scope, confidentiality measures, and voluntary nature. The questionnaire was administered through printed forms or an online survey platform, depending on participant availability and accessibility. Participants were given sufficient time to complete the questionnaire. Responses were checked for completeness, coded, encoded, and organized according to the readiness domains of the proposed architecture. Likert-scale responses were prepared for descriptive statistical analysis, while open-ended responses were reviewed to identify recurring concerns and recommendations. The study used a reclassified survey instrument originally developed to assess pedagogical, andragogical, and global instructional readiness. For the present study, selected indicators were mapped into digital capability and readiness domains because technology-enhanced education requires the integration of digital resources, instructional design, learner-centered delivery, collaboration, and globally aligned teaching practices. Items related to pedagogy, andragogy, adult learning, international standards, culturally responsive teaching, and global teaching practices were retained under training exposure and application of digital competencies.

### *2.5. Ethical Considerations*

The study observed ethical principles in the conduct of institutional and educational research. Participation was voluntary, and respondents were informed about the purpose of the study before answering the questionnaire. Informed consent was obtained, and participants were assured that they could decline or withdraw without negative consequences. Confidentiality and anonymity were maintained throughout the research process. No personal identifiers were disclosed in the presentation and interpretation of results. The data gathered were used solely for academic and research purposes. The researchers also ensured that participants were not exposed to harm, coercion, or undue pressure. Since the study involved perceptions of institutional readiness, technology-supported practices, system limitations, and support conditions, responses were treated with strict confidential-

ity. Aggregated reporting was used to ensure that findings reflected system-level readiness patterns rather than individual performance evaluation.

### 2.6. Statistical Treatment of Data

The data were analyzed using descriptive statistics. Frequency and percentage were used to describe the participants' demographic and professional profile, including age, sex, educational attainment, length of experience, specialization, and technical certification. Mean and standard deviation were used to determine the levels of digital capability and readiness across indicators such as digital literacy, technology-enhanced competence, training exposure, resource availability, institutional and technical support, attitudes toward technology-enhanced systems, perceived effectiveness, and implementation challenges. The analysis generated a descriptive readiness profile of the technology-enhanced educational system. The results were used to identify capability strengths, infrastructure and support gaps, resource-related constraints, and areas requiring institutional intervention. These outputs formed the empirical basis for readiness interpretation and decision-support reporting in the proposed architecture.

## 3. Results and Discussion

### 3.1. Human-User Dataset Profile

Table 1 summarizes the human-user dataset used in the pilot implementation of the digital capability analytics and readiness assessment architecture. The dataset consisted of 45 system users, with female users comprising 57.78% and male users comprising 42.22%. The largest age group was 31–35 years old (35.56%), indicating that most respondents were within a professionally active age range, while the inclusion of older users provided input from personnel with longer institutional exposure. Most respondents held master's degrees (73.33%), suggesting that the dataset was drawn from an academically prepared group capable of evaluating digital capability, system access, and institutional readiness conditions. This is relevant because digital capability assessment requires users who can provide informed responses on information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving, which are core areas in established digital competence frameworks [4].

**Table 1.** Human-user dataset profile for the pilot implementation of the digital capability analytics and readiness assessment architecture.

| Data Attribute | Class Label | *n* | % |
|---|---|---|---|
| Sex | Male | 19 | 42.22 |
| | Female | 26 | 57.78 |
| | Subtotal | 45 | 100.00 |
| Age Group | 20–25 years old | 5 | 11.11 |
| | 26–30 years old | 9 | 20.00 |
| | 31–35 years old | 16 | 35.56 |
| | 36–40 years old | 3 | 6.67 |
| | 41–45 years old | 1 | 2.22 |
| | 46–50 years old | 4 | 8.89 |
| | 51 years old and above | 7 | 15.56 |
| | Subtotal | 45 | 100.00 |

**Table 1.** *Cont.*

| Data Attribute | Class Label | *n* | % |
|---|---|---|---|
| Educational Attainment | Bachelor's degree | 11 | 24.44 |
| | Master's degree | 33 | 73.33 |
| | Doctorate degree | 1 | 2.22 |
| | Subtotal | 45 | 100.00 |
| Service Duration | Less than 1 year | 4 | 8.89 |
| | 1–5 years | 10 | 22.22 |
| | 6–10 years | 17 | 37.78 |
| | More than 10 years | 14 | 31.11 |
| | Subtotal | 45 | 100.00 |
| Technical Qualification | None | 9 | 20.00 |
| | National Certificate II | 34 | 75.56 |
| | Trainer's Methodology I | 4 | 8.89 |

Note: $n = 45$. Percentages were computed using the total number of system users as the denominator. Technical qualification was treated as a multiple-response attribute because some users may hold overlapping credentials; therefore, the percentages under this attribute are not additive, and no subtotal is reported.

In terms of service duration, 37.78% had 6–10 years of service, and 31.11% had more than 10 years. This indicates that most respondents had sustained experience with institutional processes and technology-supported instructional operations. The technical qualification profile also showed that 75.56% held National Certificate II credentials, while 8.89% held Trainer's Methodology I certification. These characteristics support the suitability of the pilot dataset as a human-user input layer for assessing digital capability and readiness in a technology-oriented educational system.

### *3.2. Human Digital Capability*

Table 2 presents the human digital capability indicators generated from the pilot readiness assessment dataset. The overall human digital capability index obtained a mean of 4.33 with a standard deviation of 0.33, interpreted as very high. This result indicates that the respondents generally possessed strong capability for participating in technology-enhanced educational operations.

**Table 2.** Human digital capability indicators generated from the pilot readiness assessment dataset.

| Readiness Domain | Capability Indicator | Mean | SD | Interpretation |
|---|---|---|---|---|
| Digital instructional design competence | Training in digital instructional design and technology-enhanced learning environments | 4.36 | 0.74 | Very high |
| Digital standards and interoperability awareness | Familiarity with digital learning standards, interoperability expectations, and quality benchmarks for technology-enhanced education | 4.47 | 0.50 | Very high |
| Digital literacy | Training in digital literacy, including the use of e-learning platforms and digital simulations | 4.36 | 0.61 | Very high |
| Blended/online learning readiness | Training in blended or online learning strategies | 4.58 | 0.50 | Very high |
| Andragogical digital skills | Training in adult learning strategies for technology-enhanced environments | 4.24 | 0.57 | Very high |

**Table 2.** *Cont.*

| Readiness Domain | Capability Indicator | Mean | SD | Interpretation |
|---|---|---|---|---|
| Inclusive and user-centered digital practice | Use of inclusive and user-centered digital practices that support diverse learners | 4.42 | 0.58 | Very high |
| Language and communication skills | Continuous improvement of digital and professional communication skills for technology-enhanced environments | 4.20 | 0.63 | High |
| Continuous digital professional development | Participation in conferences, webinars, or training related to digital education, educational technology, and instructional system innovation | 4.00 | 0.67 | High |
| Innovation and critical thinking | Training that enhances creativity, critical thinking, and problem-solving skills for digital and technology-driven work environments | 4.29 | 0.63 | Very high |
| Digitally aligned curriculum and workforce readiness | Capability to design digitally supported curricula aligned with workforce, industry, and technology standards | 4.36 | 0.53 | Very high |
| Overall human digital capability index | | 4.33 | 0.33 | Very high |

Note: $n = 45$. Mean values were interpreted using a five-point scale. The overall human digital capability index represents the aggregate mean of the digital capability indicators included in the pilot readiness assessment dataset.

The highest-rated indicator was blended/online learning readiness (M = 4.58, SD = 0.50), suggesting strong preparation in blended and online learning strategies. This finding is important because technology-enhanced systems require educators who can design, facilitate, and manage digital learning activities. The UNESCO ICT Competency Framework for Teachers emphasizes the need for teacher competencies in integrating digital technologies into teaching, learning, assessment, and professional practice [5]. Similarly, ref. [4] identifies teaching and learning, digital resources, assessment, learner empowerment, and professional engagement as major areas of educator digital competence. Digital standards and interoperability awareness also obtained a very high mean score (M = 4.47, SD = 0.50). This indicates that respondents were familiar with digital learning standards, interoperability expectations, and quality benchmarks. In the readiness model, this indicator is linked to system quality because effective digital implementation depends on the alignment of tools, platforms, resources, and institutional processes. The DeLone and McLean Information Systems Success Model identifies system quality, information quality, and service quality as core dimensions of information system success [1]. Inclusive and user-centered digital practice was likewise rated very high (M = 4.42, SD = 0.58), indicating that respondents perceived themselves as capable of using digital practices that support diverse learners. This result shows that digital capability is not limited to technical tool use but also includes inclusive, collaborative, and learner-centered engagement. The authors of [4] support this interpretation by identifying communication and collaboration, digital content creation, safety, and problem-solving as essential areas of digital competence [4]. Other indicators were also rated very high, including digital instructional design competence (M = 4.36, SD = 0.74), digital literacy (M = 4.36, SD = 0.61), digitally aligned curriculum and workforce readiness (M = 4.36, SD = 0.53), innovation and critical thinking (M = 4.29, SD = 0.63), and andragogical digital skills (M = 4.24, SD = 0.57). These findings indicate that the respondents had strong capability in designing technology-supported instruction, using digital platforms and simulations, aligning curricula with workforce standards, and applying problem-solving skills in digital environments. The comparatively

lower indicators were continuous digital professional development (M = 4.00, SD = 0.67) and language and communication skills (M = 4.20, SD = 0.63). Although both remained high, they point to areas where targeted capacity-building may improve long-term readiness. This is consistent with UNESCO-UNEVOC, which emphasizes that TVET systems need teachers and trainers with continuously updated digital capabilities to respond to digitalization [6].

### *3.3. Training Exposure Indicators*

Table 3 presents the training-exposure indicators for digitally supported instructional competence. The overall training-exposure index obtained a mean of 4.38 with a standard deviation of 0.43, interpreted as very high. This indicates that respondents had strong exposure to and application of digitally supported instructional competencies. The highest-rated indicator was familiarity with principles of digital and adult learning in technology-enhanced environments (M = 4.62, SD = 0.61). This suggests that respondents had strong conceptual grounding in digital and adult-learning principles. Such preparation is important because technology-enhanced instruction requires alignment among digital tools, learner needs, instructional objectives, and professional learning contexts. The authors of [4] identified professional engagement, digital resources, teaching and learning, assessment, learner empowerment, and facilitation of learners' digital competence as key areas of educator digital competence [7].

**Table 3.** Training-exposure indicators for digitally supported instructional competence.

| | Training-Exposure Indicator | Mean | SD | Interpretation |
|---|---|---|---|---|
| 1. | Familiarity with principles of digital and adult learning in technology-enhanced environments | 4.62 | 0.61 | Very high |
| 2. | Application of digital pedagogical and andragogical strategies in instructional design and delivery | 4.49 | 0.55 | Very high |
| 3. | Confidence in implementing digital learning strategies for adult and diverse learners | 4.20 | 0.55 | High |
| 4. | Training preparation for digital and technology-driven work environments | 4.16 | 0.42 | High |
| 5. | Continuous updating of knowledge on digital standards and technology-enhanced instructional practices | 4.40 | 0.69 | Very high |
| 6. | Use of culturally responsive and technology-supported teaching strategies | 4.56 | 0.69 | Very high |
| 7. | Confidence in designing digitally supported curricula aligned with digital competency and industry technology standards | 3.96 | 0.42 | High |
| 8. | Collaboration with colleagues in sharing digital tools, online resources, and technology-enhanced instructional practices | 4.44 | 0.62 | Very high |
| 9. | Integration of digital literacy in lesson planning to support digital and technology-enhanced learning | 4.60 | 0.62 | Very high |
| | Overall training-exposure index | 4.38 | 0.43 | Very high |

Note: $n$ = 45. Mean values were interpreted using a five-point scale. The overall training-exposure index represents the aggregate mean of the indicators measuring exposure to and application of digitally supported instructional competencies.

The integration of digital literacy in lesson planning also obtained a very high mean score (M = 4.60, SD = 0.62). This result indicates that respondents were able to embed digital literacy into instructional planning. Since [4] defines digital competence through information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving, this finding suggests that respondents were able to translate general digital competence into instructional design practice [4]. The use of culturally re-

sponsive and technology-supported teaching strategies was also rated very high (M = 4.56, SD = 0.69). This indicates that respondents recognized the importance of learner diversity and contextual responsiveness in digital instruction. Other strong indicators included the application of digital pedagogical and andragogical strategies (M = 4.49, SD = 0.55), collaboration with colleagues in sharing digital tools and online resources (M = 4.44, SD = 0.62), and continuous updating of knowledge on digital standards and technology-enhanced practices (M = 4.40, SD = 0.69). The lowest-rated indicator was confidence in designing digitally supported curricula aligned with digital competency and industry technology standards (M = 3.96, SD = 0.42). Although still interpreted as high, this result identifies curriculum alignment as a priority area for further training. This is particularly relevant in technology-oriented and technical–vocational settings, where digital transformation requires stronger alignment among teacher capability, workforce requirements, and industry-relevant technologies [6].

### 3.4. Resource Availability, Technical Infrastructure, and Institutional System Support

Table 4 presents the resource, infrastructure, and institutional support readiness indicators. The overall infrastructure and support readiness index obtained a mean of 4.42 with a standard deviation of 0.38, interpreted as very high. This result indicates that respondents generally perceived the institutional environment as supportive of technology-enhanced educational operations. The highest-rated indicator was access to digital tools, including e-learning platforms and simulations (M = 4.62, SD = 0.61). This suggests strong perceived availability of digital tools needed for instructional delivery and system-supported learning. The Unified Theory of Acceptance and Use of Technology identifies facilitating conditions as a major determinant of technology use, particularly when users rely on organizational and technical infrastructure to perform technology-mediated tasks [3].

**Table 4.** Resource, infrastructure, and institutional support readiness indicators.

| | Support-Readiness Indicator | Mean | SD | Interpretation |
|---|---|---|---|---|
| 1. | Availability of up-to-date learning materials and equipment for technology-enhanced education | 4.58 | 0.54 | Very high |
| 2. | Access to digital tools, including e-learning platforms and simulations | 4.62 | 0.61 | Very high |
| 3. | Institutional support for professional growth | 4.47 | 0.55 | Very high |
| 4. | Industry partnerships that enhance technology-oriented instruction | 4.53 | 0.55 | Very high |
| 5. | Mentorship for improving technology-enhanced instructional practice | 4.36 | 0.65 | Very high |
| 6. | Regular training on emerging digital technologies and instructional systems | 4.20 | 0.55 | High |
| 7. | Budget allocation for digital tools, platforms, and technology-enhanced resources | 4.47 | 0.66 | Very high |
| 8. | Encouragement to participate in international conferences or webinars | 4.24 | 0.61 | Very high |
| 9. | Promotion of research and innovation in technology-enhanced education | 4.29 | 0.66 | Very high |
| 10. | Availability of technical support for integrating digital tools | 4.42 | 0.62 | Very high |
| Overall infrastructure and support readiness index | | 4.42 | 0.38 | Very high |

Note: $n$ = 45. Mean values were interpreted using a five-point scale. The overall infrastructure and support readiness index represents the aggregate mean of indicators measuring resource availability, digital infrastructure, technical support, and institutional support mechanisms.

The availability of up-to-date learning materials and equipment also received a very high rating (M = 4.58, SD = 0.54). This supports the system-quality dimension of readiness because users depend on relevant resources, reliable systems, and service support for meaningful system use. DeLone and McLean identify system quality, information quality,

and service quality as central dimensions of information system success [1]. Industry partnerships that enhance technology-oriented instruction were also rated very high (M = 4.53, SD = 0.55). This finding indicates that external linkages contribute to instructional relevance, workforce alignment, and technology-oriented learning. In TVET contexts, such partnerships are important because digitalization changes workplace skills, instructional technologies, and training requirements [6]. Other indicators also showed strong support conditions, including institutional support for professional growth (M = 4.47), budget allocation for digital tools and platforms (M = 4.47), availability of technical support (M = 4.42), mentorship for technology-enhanced practice (M = 4.36), promotion of research and innovation (M = 4.29), and encouragement to participate in conferences or webinars (M = 4.24). The lowest-rated indicator was regular training on emerging digital technologies and instructional systems (M = 4.20, SD = 0.55). Although this remained high, it suggests the need for more sustained and structured professional development. Similarly, ref. [4] emphasizes continuous professional engagement in the effective use of digital technologies for teaching, learning, assessment, and learner empowerment [7].

### *3.5. Constraint Indicators*

Table 5 presents the constraint indicators affecting digital capability and system readiness. The most frequently reported constraint was limited access to digital tools and technology, identified by 36 respondents or 80.00% of the pilot dataset. This result requires careful interpretation because Table 4 showed very high perceived access to digital tools. The contrast suggests that tools may be generally available but not always sufficient, consistent, updated, equally distributed, or fully aligned with users' instructional needs. This finding strengthens the value of including constraint indicators in the readiness architecture. Mean-based readiness scores can show generally favorable conditions, while frequency-based constraint data can reveal specific implementation issues. From a systems perspective, user competence does not automatically ensure readiness; access, usability, reliability, and support conditions remain essential. This interpretation is consistent with UTAUT, which identifies facilitating conditions as an important factor in technology use [3], and with the DeLone and McLean model, which links system quality, information quality, and service quality with system use and benefits [1].

**Table 5.** Constraint indicators affecting digital capability and system readiness.

| | Constraint Indicator | f | % |
|---|---|---|---|
| 1. | Limited access to digital tools and technology | 36 | 80.00 |
| 2. | Insufficient institutional support | 17 | 37.78 |
| 3. | Difficulty adapting to technology-enhanced processes | 16 | 35.56 |
| 4. | Limited awareness of emerging digital workforce and industry technology requirements | 11 | 24.44 |
| 5. | Limited exposure to effective technology-enhanced instructional system models | 11 | 24.44 |
| 6. | Lack of training in technology-enhanced instructional system integration | 10 | 22.22 |
| 7. | Difficulty shifting from traditional practices to digital workflows | 9 | 20.00 |
| 8. | Curriculum and system practices not fully aligned with digital and industry standards | 8 | 17.78 |

Note: $n = 45$. Percentages were computed using the total number of system users as the denominator. Multiple responses were allowed; therefore, percentages are not additive. Shared rank values indicate tied frequencies.

The second most frequently reported constraint was insufficient institutional support (f = 17, 37.78%), followed by difficulty adapting to technology-enhanced processes (f = 16, 35.56%). These results indicate that organizational and behavioral readiness remain important even when overall capability and support indices are high. The UNESCO ICT

Competency Framework for Teachers emphasizes that effective ICT integration requires not only individual competence but also policy support, curriculum alignment, organizational arrangements, professional learning, and administrative support. Two constraints shared the next rank: limited awareness of emerging digital workforce and industry technology requirements (f = 11, 24.44%) and limited exposure to effective technology-enhanced instructional system models (f = 11, 24.44%). These findings suggest the need for stronger exposure to industry-relevant digital trends, benchmark systems, and operational models. This is especially important in technical–vocational settings, where digitalization requires teachers and trainers to respond to changing work environments and technology-driven skills demands [5]. Lack of training in technology-enhanced instructional system integration (f = 10, 22.22%) and difficulty shifting from traditional practices to digital workflows (f = 9, 20.00%) further indicate that readiness must be supported through continuous professional development, mentoring, and guided implementation. The least reported constraint was curriculum and system practices not fully aligned with digital and industry standards (f = 8, 17.78%). Although lowest in frequency, this remains important because curriculum and standards alignment affect the coherence, scalability, and sustainability of digital transformation.

## 4. Conclusions

This study developed and pilot-tested a data-driven architecture for digital capability analytics and readiness assessment in a technology-enhanced educational system. The architecture organized human capability, training exposure, infrastructure readiness, institutional support, and implementation constraints into measurable indicators for readiness interpretation and decision-support reporting. The pilot results showed very high readiness across three major areas: human digital capability, training exposure, and infrastructure and institutional support. Respondents demonstrated strong preparation in blended and online learning, digital instructional design, digital literacy, inclusive digital practice, standards awareness, and workforce-aligned curriculum development. Training exposure was strongest in digital and adult-learning principles, digital literacy integration, culturally responsive technology-supported teaching, and collaborative sharing of digital resources. Infrastructure and support indicators also showed favorable conditions, particularly in access to digital tools, updated materials, industry partnerships, budgetary support, technical support, and professional growth mechanisms. However, the constraint indicators revealed that high readiness scores do not fully remove implementation barriers. Limited access to digital tools and technology remained the most frequently reported constraint, followed by insufficient institutional support, adaptation difficulty, limited exposure to emerging workforce and industry technology requirements, lack of training in system integration, and difficulty shifting from traditional practices to digital workflows. These findings suggest that readiness should be treated as a dynamic condition shaped by user capability, consistency of access, quality of support, adaptability, and curriculum alignment. The study contributes a scalable assessment architecture that converts readiness data into actionable indicators for planning, resource allocation, professional development, infrastructure improvement, and technology governance. Its main value lies in combining aggregate readiness indices with constraint indicators to identify both capability strengths and implementation risks. The study is limited by its pilot scope, single-institution setting, purposive sampling, and reliance on self-reported data. Future studies may expand the architecture across multiple institutions, include larger samples, integrate objective system-use data, and apply advanced analytics such as predictive modeling, dashboard monitoring, or comparative readiness profiling.

https://doi.org/10.3390/engproc2026143057

**Author Contributions:** Conceptualization, D.F.F.B., J.M.B., J.I.G. and R.L.M.; methodology, D.F.F.B., J.M.B., J.I.G. and R.L.M.; software, D.F.F.B., J.M.B., J.I.G. and R.L.M.; validation, D.F.F.B., J.M.B., J.I.G. and R.L.M.; formal analysis, D.F.F.B., J.M.B., J.I.G. and R.L.M.; investigation, D.F.F.B., J.M.B., J.I.G. and R.L.M.; resources, D.F.F.B., J.M.B., J.I.G. and R.L.M.; data curation, D.F.F.B., J.M.B., J.I.G. and R.L.M.; writing—original draft preparation, D.F.F.B., J.M.B. and J.I.G.; writing—review and editing, D.F.F.B., J.M.B., J.I.G. and R.L.M.; visualization, D.F.F.B., J.M.B., J.I.G. and R.L.M.; supervision, R.L.M. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding. The authors wish to extend appreciation to the Caraga State University for the funding support.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Informed consent was obtained from all participants involved in the study.

**Data Availability Statement:** The data presented in this study are available upon request from the corresponding author through rlmariscal@carsu.edu.ph.

**Acknowledgments:** The authors wish to extend their gratitude to Caraga State University for the support extended to the researchers.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## Abbreviations

The following abbreviations are used in this manuscript:

| | |
|---|---|
| TVET | Technical and Vocational Education and Training |
| TAM | Technology Acceptance Model |
| UTAUT | Unified Theory of Acceptance and Use of Technology |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNEVOC | International Center for Technical and Vocational Education and Training |

## References

1. DeLone, W.H.; McLean, E.R. The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. *J. Manag. Inf. Syst.* **2003**, *19*, 9–30. [CrossRef]
2. Davis, F.D. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *Manag. Inf. Syst. Q.* **1989**, *13*, 319–340. [CrossRef] [PubMed]
3. Venkatesh, V.; Morris, M.G.; Davis, G.B.; Davis, F.D. User Acceptance of Information Technology: Toward a Unified View. *MIS Q.* **2003**, *27*, 425–478. [CrossRef]
4. Vuorikari, R.; Kluzer, S.; Punie, Y. *DigComp 2.2 The Digital Competence Framework for Citizens—With New Examples of Knowledge, Skills and Attitudes*; Publications Office of the European Union: Luxembourg, 2022. Available online: https://www.scirp.org/reference/referencespapers?referenceid=3486400 (accessed on 29 June 2026).
5. UNESCO. *UNESCO ICT Competency Framework for Teachers: Version 3*; UNESCO: Paris, France, 2018.
6. Subrahmanyam, G. *Digital Skills Development in TVET Teacher Training. Trends Mapping Study*; UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training: Bonn, Germany, 2022.
7. Redecker, C.; Punie, Y. *European Framework for the Digital Competence of Educators DigCompEdu*; Publications Office of the European Union: Luxembourg, 2017. Available online: https://www.scirp.org/reference/referencespapers?referenceid=2927523 (accessed on 29 June 2026).

**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.