Received: 07 Dec. 2025 | **Revised:** 15 Mar. 2026 | **Accepted:** 20 Mar. 2026 | **e-ISSN:** 3085-7813

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ARTICLE

TEACHER LEADERSHIP IN THE DIGITAL ERA: LEVERAGING COMPETITIVE INTELLIGENCE FOR SUSTAINABLE EDUCATIONAL INNOVATION

LIDERANÇA DOCENTE NA ERA DIGITAL: APROVEITAR A INTELIGÊNCIA COMPETITIVA PARA UMA INOVAÇÃO EDUCATIVA SUSTENTÁVEL

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Editor in chief
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How to cite this article:

Liu, H. (2026). Teacher Leadership in the Digital Era: Leveraging Competitive Intelligence for Sustainable Educational Innovation. *Journal of Sustainable Competitive Intelligence*, *16*, e0635. https://doi.org/10.37497/eagleSustainable.v16i.635

ABSTRACT

Purpose: Teacher leadership has become increasingly important in digitally mediated education systems requiring adaptive decision-making. This study investigates how teacher leadership, supported by competitive intelligence, contributes to sustainable educational innovation.

Methodology/approach: Data were collected from 98 educators using structured questionnaires. The framework integrates Competitive Intelligence Utilization (CIU) with teacher leadership competencies. Analysis was conducted using exploratory factor analysis, reliability testing, correlation, and multiple regression in IBM SPSS Statistics version 28.

Originality/Relevance: Highlights integrating competitive intelligence with teacher leadership to enhance sustainable educational innovation.

Key findings: Competitive intelligence significantly affects sustainable educational innovation ($\beta = 0.41$, $p < 0.01$), while teacher leadership explains 57% of the variance. Institutions using structured intelligence show higher innovation, adaptability, and instructional improvement.

Theoretical/methodological contributions: Provides a framework combining CIU and teacher leadership, using statistical modeling to explain innovation-driven educational practices.

Keywords: Teacher leadership. Competitive intelligence. Educational innovation. Digital era education. Strategic information utilization. Institutional sustainability.

DOI: https://doi.org/10.37497/eagleSustainable.v16i.635

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RESUMO

Objetivo: A liderança docente tem vindo a assumir uma importância crescente nos sistemas educativos mediados digitalmente, que exigem uma tomada de decisões adaptativa. Este estudo investiga de que forma a liderança docente, apoiada pela inteligência competitiva, contribui para a inovação educativa sustentável.

Metodologia/abordagem: Os dados foram recolhidos junto de 98 educadores através de questionários estruturados. O quadro conceptual integra a Utilização da Inteligência Competitiva (CIU) com as competências de liderança docente. A análise foi realizada utilizando análise fatorial exploratória, testes de fiabilidade, correlação e regressão múltipla no IBM SPSS Statistics versão 28.

Originalidade/Relevância: Destaca a integração da inteligência competitiva com a liderança docente para promover a inovação educativa sustentável.

Principais conclusões: A inteligência competitiva tem um impacto significativo na inovação educativa sustentável ($\beta = 0,41$, $p < 0,01$), enquanto a liderança docente explica 57% da variância. As instituições que utilizam a inteligência estruturada apresentam níveis mais elevados de inovação, adaptabilidade e melhoria do ensino.

Contribuições teóricas/metodológicas: Apresenta um quadro conceptual que combina a inteligência competitiva e a liderança docente, recorrendo à modelação estatística para explicar práticas educativas orientadas para a inovação.

Palavras-chave: Liderança docente. Inteligência competitiva. Inovação educativa. Educação na era digital. Utilização estratégica da informação. Sustentabilidade institucional.

1 INTRODUCTION

The digital transformation of education has redefined the role of teachers from knowledge transmitters to strategic actors engaged in data-driven decision-making, innovation, and collaborative leadership (Peng, 2022). Teacher leadership in digitally mediated contexts involves guiding instructional processes, fostering collaboration, and leveraging technology to improve learning outcomes (Mustari and Nurhayati, 2024). A critical yet underexplored capability in this transformation is Competitive Intelligence

(CI), which extends beyond routine data use by enabling the systematic sensing, interpretation, and strategic application of internal and external information to support adaptive decision-making (Rasdiana et al., 2024). Digital leadership and technology-driven supervision affect the digital competence and performance of teachers positively, as in accordance with the studies. As an example, the outcomes of structural equation modelling in recent educational research reveal that there are strong connections between technology leadership and school digital culture and between digital culture and the professional digital competence of teachers (Mushadi et al., 2025). Nevertheless, there are several problems, such as disparities in the digital infrastructure, technological proficiency of instructors, lack of time, and the challenge of data analysis (Supriadi, 2025). The rapid digital transformation of education has increased the reliance on data, technology, and adaptive teaching practices. However, existing research predominantly treats information as a passive resource, focusing on digital tools, data use, or leadership practices in isolation. This fragmented perspective limits understanding of how information can be strategically interpreted and utilized to drive sustainable innovation. This creates a critical gap in understanding how educational institutions can systematically interpret and utilize information to support sustainable innovation.

Competitive Intelligence (CI) provides a theoretical framework to address this limitation. Within this context, CI provides a more advanced conceptual lens by framing information as a strategic capability rather than a technical input. Unlike digital competence or data utilization, CI emphasizes forward-looking analysis, environmental scanning, and the transformation of information into actionable insights. Despite its extensive application in business and strategic management, its integration into educational research remains limited and conceptually underdeveloped. Unlike general data use or digital competence, CI involves the structured collection, analysis, and strategic application of internal and external information to support decision-making and organizational adaptation. While CI has been widely studied in business and strategic management contexts, its application in education remains underdeveloped and conceptually fragmented. In many cases, it is implicitly reduced to data usage, digital supervision, or benchmarking, without recognizing its role as a forward-looking and interpretive capability.

Although prior studies acknowledge the benefits of digital leadership and innovation, they rarely examine how intelligence utilization interacts with leadership processes to shape sustainable educational innovation. This gap highlights the need for an integrated framework linking CIU, teacher leadership, and innovation outcomes (Surohmat & Firdaus, 2025). Although statistical methods are applicable in modeling correlation between variables, sample limitations, cross-sectional data, and contextual bias can limit their generalizability across different educational settings (Adeoye et al., 2024). A cohesive strategy on the development of quantitative modelling and qualitative knowledge, lifelong learning, development of collaborative digital cultures, and facilitation of infrastructure to overcome these shortcomings (Salīte et al., 2024). Combining competitive intelligence practice with the teacher leadership practice, educational institutions will be able to develop sustainable innovation, improve their

teacher competencies and develop flexible learning environments that will meet the needs of the digital age.

This study examines how teacher leadership and competitive intelligence utilization are associated with sustainable educational innovation. By integrating these constructs, the study aims to provide a more comprehensive understanding of how intelligence-driven leadership can support adaptive and innovation-oriented educational environments. The results could also be an educational change strategic baseline in the long run because it can assist institutions and politicians to create data-based measures in leadership formation and technical integration project implementation.

1.1 Research Objective and Contribution

This study aims to examine the relationships among Competitive Intelligence Utilization (CIU), Teacher Leadership (TL), and Sustainable Educational Innovation (SEI) within educational institutions. The key contributions of this study are as follows:

Theoretical Contribution: It conceptualizes CIU as a strategic capability within education, extending competitive intelligence theory beyond traditional business contexts.

Conceptual Contribution: It develops an integrated framework linking intelligence utilization, leadership processes, and innovation outcomes.

Empirical Contribution: It provides quantitative evidence on the relationships among CIU, TL, and SEI using regression-based path analysis.

Practical Contribution: It offers insights for educational institutions on how intelligence-driven leadership can support sustainable innovation.

1.2 Research Organization

The study is organized in such a way that the introduction is presented in Section 1, and it focuses on the significance of teacher leadership, application of competitive intelligence, and sustainable educational innovation. In Section 2, relevant research on innovation in educational contexts, intelligence-driven practices, and digital leadership is reviewed. Research hypothesis that connect CIU, teacher leadership, and sustainable educational innovation are explained in Section 3. The technique, including data collection, sampling, and statistical analysis, is covered in Section 4. Results and analysis are presented in Section 5, and the practical consequences and future research possibilities are highlighted in Section 6.

2 THEORETICAL FRAMEWORK

This study is grounded in the dynamic capability perspective, which emphasizes an organization's ability to sense, interpret, and respond to environmental changes through the strategic use of information. In educational contexts, this perspective provides

a useful lens to understand how institutions adapt to digital transformation through intelligence-driven processes and leadership practices. Within this framework, Competitive Intelligence (CI) is conceptualized as a dynamic capability that enables the systematic sensing, analysis, and strategic use of information. Unlike routine data usage or digital tools, CI involves transforming fragmented information into actionable insights that support decision-making and organizational adaptation. In educational settings, CI allows institutions to anticipate technological trends, interpret complex learning environments, and align innovation strategies with evolving demands. However, intelligence alone does not generate outcomes unless it is effectively interpreted and enacted. Leadership plays a critical role in translating intelligence into practice. Teacher Leadership (TL) functions as an enabling mechanism through which intelligence is disseminated, interpreted, and applied within instructional and institutional contexts.

Teacher leadership in digital environments extends beyond administrative roles to include collaborative decision-making, instructional innovation, and the strategic use of information. From this perspective, leadership acts as a bridge between intelligence and action, facilitating the integration of knowledge into teaching practices and organizational processes. Sustainable Educational Innovation (SEI) is conceptualized as the outcome of intelligence-driven leadership processes. It reflects the ability of educational institutions to continuously adapt, innovate, and sustain improvements in teaching and learning practices in response to changing technological and societal conditions. Based on this theoretical integration, this study proposes that Competitive Intelligence Utilization (CIU) enhances Sustainable Educational Innovation (SEI) both directly and indirectly through Teacher Leadership (TL). CIU provides the informational foundation, TL enables its application, and SEI represents the resulting adaptive and innovative capacity of educational institutions.

Mogas et al. (2022) investigated the idea of smart schools and their preparedness for the Fourth Industrial Revolution. 37 principals from primary and secondary schools in Catalonia were interviewed. Results show that although schools acknowledge the need for digital transformation, they are far from putting cutting-edge technology into practice. Government laws provide a strong emphasis on inclusion, whereas resource limitations force sustainability to get less attention. The dependence on principals' views and a small geographical sample. The management of digital change in educational institutions was investigated in a multiple-case study including 35 participants, including Indonesian teachers, university administrators, and school principals (Freser, 2025). Thematic analysis showed that while institutional flexibility and cultural preparedness have a major impact on sustainable digital practices, collaborative and visionary leadership propels innovation. Nevertheless, there were several drawbacks, such as the small sample size and the qualitative methodology, which can restrict generalizability in other educational settings.

Competitive Intelligence (CI) is defined as a systematic and strategic process of collecting, analyzing, and applying information about internal and external environments to support decision-making and organizational adaptation. In educational contexts, CI extends beyond routine data usage by enabling institutions to anticipate trends, interpret

complex learning environments, and align innovation strategies with emerging technological and societal demands. This study positions Competitive Intelligence Utilization (CIU) as a dynamic capability that supports leadership processes and drives sustainable educational innovation.

The leadership paradigm was used in qualitative research conducted in a library to examine the roles of principals in the Society 5.0 era. Isbahi (2023) findings show that to reform schools, effective leaders must possess visionary abilities and serve as educators, administrators, innovators, and motivators. However, practical confirmation of these conclusions is limited by the absence of empirical data and dependence on secondary sources. Küçükuncular & Ertugan (2025) used Marx's theory of alienation; an exploratory survey of 395 educators in Northern Cyprus examined the incorporation of Artificial Intelligence. The findings indicate that while positive views of Artificial Intelligence somewhat mitigate these consequences, AI can worsen alienation from work, professional identity, and interpersonal relationships. The robustness of results (Cronbach's $\alpha = 0.42$) was limited by the early adoption of AI and the low dependability of the AI perception scale. From a competitive intelligence perspective, prior research highlights the role of data-driven systems and business intelligence as foundational mechanisms for strategic decision-making. Studies on business intelligence (Alhawamdeh et al., 2024; Jiménez-Partearroyo & Medina-López, 2024) demonstrate that intelligence systems transform raw data into actionable insights, enabling organizations to enhance innovation, adaptability, and competitive advantage. However, these studies largely remain within corporate contexts and lack application to educational environments. Leadership plays a critical role in operationalizing competitive intelligence. Research on digital and transformational leadership (Zada et al., 2025; Hussein et al., 2024; Qiao et al., 2024) suggests that leadership functions as a mediating mechanism through which intelligence is translated into innovation outcomes. In educational contexts, leadership enables the interpretation, dissemination, and application of intelligence to support collaborative teaching, institutional learning, and strategic adaptation. However, existing studies rarely conceptualize leadership explicitly within a competitive intelligence framework.

The Chinese IT industry took part in a time-lagged study that looked at the impact of digital leadership in fostering sustainability and green innovation among 413 workers (Zada et al., 2025). Results indicate that top management innovativeness enhances the favorable impact of digital leadership on green innovation, which partially mediates organizational sustainability. The sector-specific concentration restricts its wider application. Amin & Khan (2024) suggested a comprehensive analysis of 120 academic publications examined how knowledge management, leadership, innovation, and dynamic capacities support digital transformation and competitive advantage. It has been discovered that information sharing and transformational leadership greatly increase organizational creativity and agility. However, causal inference was limited by the use of secondary literature and the lack of empirical testing.

Conceptual investigation examined how leadership and business intelligence (BI) foster innovation in the commercial banking industry (Alhawamdeh et al., 2024).

Research demonstrates that data-driven leadership and decision-making improve competitiveness, strategic innovation, and operational efficiency. Due to the reliance on theoretical analysis, it was limited by the absence of empirical confirmation. In an analysis of 323 middle-line managers in Saudi Arabia's tourism and hospitality sector. Hussein et al. (2024) examined the effect of digital leadership on sustainable competitive advantage. The findings show that eco-innovation and green absorptive capacity, which mediate competitive success, were improved by digital leadership. The findings' applicability to other sectors was restricted by the sector-specific emphasis.

Jiménez-Partearroyo & Medina-López (2024) conducted dual-method research that included bibliometric and qualitative analysis, examining the development of Business Intelligence (BI) over 20 years. Results show that, particularly when combined with AI and Internet of Things (IoT), BI has evolved from a supporting tool to a strategic driver of innovation, knowledge management, and competitive advantage. Reliance on particular publications, which may ignore more general business standards. To improve learning, accessibility, and sustainability, conceptual research in higher education investigated the merging of AI with living intelligence (Allam et al., 2025). AI-driven platforms increase institutional efficiency and customization, yet they are hampered by ethical issues, data protection, and legal issues. The impact of these treatments cannot be quantified due to a lack of empirical data.

Qiao & Hong (2024) examined how digital leadership plays a critical role in raising employee performance and organizational commitment. According to data collected from 579 participants across a variety of sectors, digital transformation fosters creativity and resilience by mediating and amplifying the beneficial impacts of leadership on results. The cross-sectional design limits causal inference and the evaluation of long-term effects. Fullan's Technology, Pedagogy, and Change knowledge framework and school-based management literature were used to introduce school-driven digital innovation in Sub-Saharan Africa, as introduced by (Quaicoe et al., 2023). Pedagogical innovation is a conceptual model that uses concept maps and active learning to show the relationships between digital transformation metrics. Reliance on secondary literature, which restricts empirical validation and calls for field testing and stakeholder participation.

2.1 Competitive Intelligence Utilization (CIU)

Competitive Intelligence Utilization (CIU) is conceptualized as a structured and cyclical process involving the systematic collection, analysis, interpretation, and strategic application of information to support decision-making. Unlike routine data use or digital information access, CIU represents an intelligence system that transforms dispersed data into actionable insights.

This process follows an intelligence cycle: first, relevant information is collected from internal and external environments; second, the information is analyzed and interpreted to identify patterns, trends, and strategic implications; third, the resulting intelligence is applied to guide decision-making and innovation. In educational contexts,

CIU enables institutions to anticipate changes, evaluate emerging practices, and align instructional strategies with evolving technological and institutional demands.

Thus, CIU extends beyond data-driven practices by emphasizing interpretation, foresight, and strategic action, making it a critical capability for adaptive and innovation-oriented educational systems.The systematic collection, assessment, and application of technical and educational data are called CIU. To increase the efficacy of teaching and promote innovativeness in academic institutions, it provides teachers with the capability to monitor emerging trends, to assess the best practices, to process the institutional performance data, and to implement the findings practically.

2.2 Teacher Leadership (TL)

TL entails the capability of teachers to guide, affect, and collaborate in instructional teams. It gives educators the capability to enhance pedagogical progress and an ethos of sustainable educational innovation through incorporating strategic consciousness, collaborative influence, information translation, and an innovation-focused state of mind.

2.3 Sustainable Educational Innovation (SEI)

SEI measures the implications of the instruction methods on long-term institutional innovation and adaptation. It currently focuses heavily on the application of the latest technological methods, ongoing improvement of teaching strategies, promotion of collaborative curriculum development, and ensuring that educational strategies remain profitable, adaptable, and sustainable in the face of academic change. Sustainable Educational Innovation (SEI) is conceptualized as the outcome of intelligence-driven leadership processes. It reflects the ability of educational institutions to continuously adapt, implement, and sustain innovative teaching and learning practices over time. SEI captures not only the adoption of new methods but also the institutional capacity to maintain and evolve these practices in response to changing technological and educational environments.

2.4 Hypothesis development

This study proposes a conceptual model examining the relationships among Competitive Intelligence Utilization (CIU), Teacher Leadership (TL), and Sustainable Educational Innovation (SEI). Drawing on the competitive intelligence and leadership literature, the model assumes that intelligence-driven practices support leadership development, which in turn enhances innovation outcomes in educational institutions.

H1: Competitive Intelligence Utilization (CIU) is positively associated with Teacher Leadership (TL).

CIU provides educators with structured, relevant, and forward-looking information that supports strategic awareness and decision-making. Access to and use of intelligence

enhances teachers' ability to coordinate, influence, and guide innovation processes within educational environments.

H2: Teacher Leadership (TL) is positively associated with Sustainable Educational Innovation (SEI)

Teacher leadership enables the implementation of innovative teaching practices by fostering collaboration, knowledge sharing, and adaptive instructional strategies. Leadership behaviors facilitate the translation of ideas into sustainable institutional practices.

H3: Competitive Intelligence Utilization (CIU) is positively associated with Sustainable Educational Innovation (SEI)

CIU supports innovation by enabling institutions to identify emerging trends, evaluate external environments, and make informed strategic decisions. This enhances the capacity of educational institutions to adapt and sustain innovation over time.

H4: TL mediates the relationship between the usage of CIU and SEI.

Teacher leadership alone stimulates innovation; however, it is more effective in combination with CIU. Leaders can be more effective in planning, implementing, and sustaining innovative practices with the help of intelligence. CIU, in this instance, can be used as an intermediary; teacher leadership promotes the effective utilization of intelligence, which enhances the outcomes of sustainable educational innovation.

This is a quantitative study aimed at examining the role of TL and CIU in fostering SEI. The research evaluates the suggested paths based on the data provided by 98 respondents and presents them in Figure 1 below.

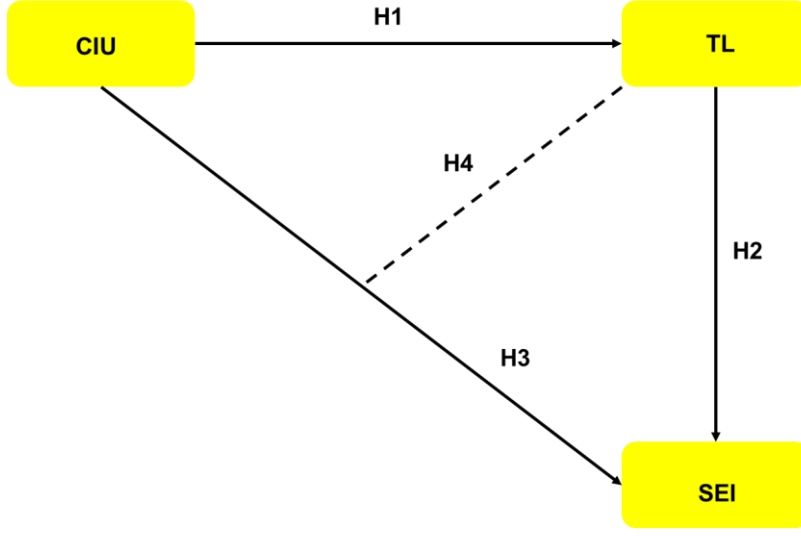

Figure 1: Conceptual framework Hypothesis Development

Given the exploratory nature of the study and the sample size, the proposed mediation model is examined using regression-based path analysis rather than full

structural equation modeling. Therefore, the results should be interpreted as indicative of relational patterns rather than confirmatory causal effects.

3 METHOD

The relationship between TL and CIU with SEI was examined using a quantitative survey approach. The data were collected using structured questionnaires that involved 98 teachers in secondary and higher learning institutions. In order to assess the relationships among TL, CIU and innovation outcomes, the IBM SPSS statistics version 28 was employed to conduct the exploratory factor analysis, reliability test, correlation, and multiple regression modeling as indicated in Figure 2.

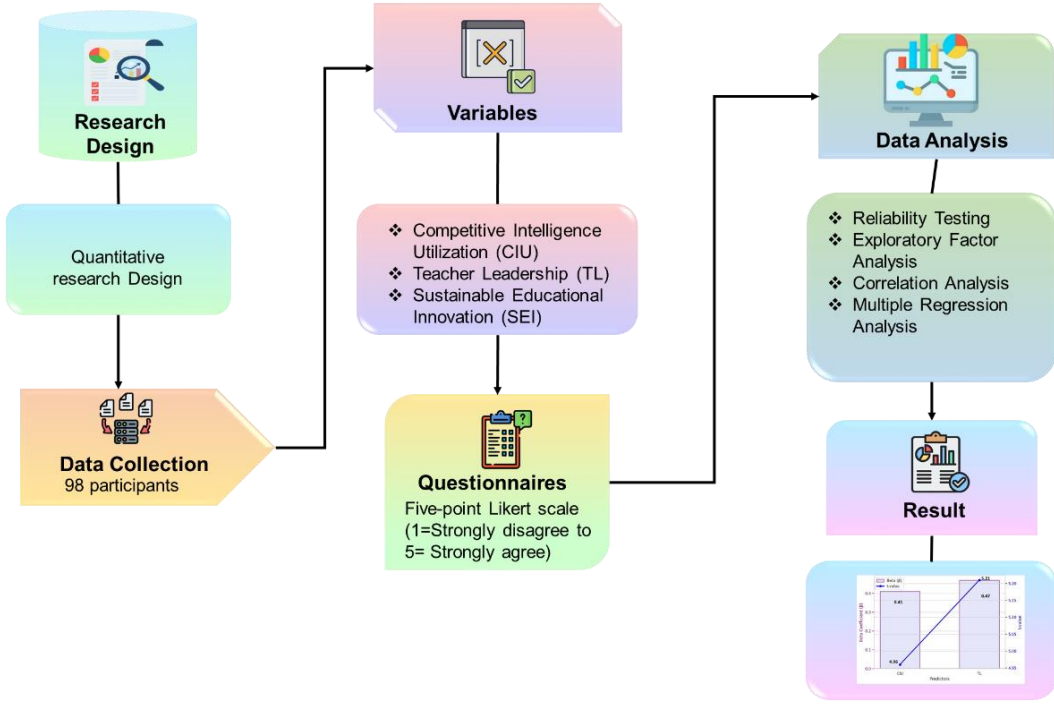

Figure 2: Quantitative Research Methodology Framework for Survey Data Collection and Analysis

3.1 Research Design

The association between the role of teacher leadership, application of CIU, and SEI in digitally mediated academic settings is analyzed through quantitative research design. The following was used to collect empirical data of teachers involved in secondary and higher education institutions. The design allows for the statistical examination of associations between competitive intelligence practices, teacher

leadership, and sustainable educational innovation within digitally mediated academic contexts

3.2 Data Collection

The primary data was gathered using structured digital questionnaires that were disseminated through online survey platforms and institutional communication channels. Teachers who actively used digital learning platforms, collaborative teaching methods, and data-driven teaching were the target participants. Teachers at secondary schools, colleges, and universities provided 98 valid replies in total. Teachers with expertise in digital learning and institutional innovation were the focus of convenience sampling. To protect privacy and ethical compliance, all responses were anonymized during the four-week survey period. The sample size of 98 participants is considered adequate for exploratory quantitative analysis and aligns with prior studies employing EFA and regression techniques in educational research. Additionally, the inclusion of respondents from both secondary and higher education enhances the diversity of perspectives and supports the exploratory nature of the study. Although the sample size is relatively modest ($n = 98$), it is considered adequate for exploratory analysis using EFA and multiple regression, and the study does not aim to estimate a full structural equation model.

3.3 Questionnaire

The purpose of the questionnaire was to assess the connection between SEI, TL, and the use of CIU. It evaluated how teachers gather and use strategic knowledge, show leadership in the classroom, and utilize cutting-edge techniques that support long-term institutional adaptation and cooperative instructional development using a five-point Likert scale (1=Strongly disagree to 5= Strongly agree).

3.4 Data Analysis

Data analysis was conducted using IBM SPSS Statistics version 28 following a structured multi-stage analytical procedure. First, Exploratory Factor Analysis (EFA) was performed to validate the underlying factor structure of the constructs. Prior to conducting EFA, sampling adequacy was assessed using the Kaiser–Meyer–Olkin (KMO) measure, and Bartlett's Test of Sphericity was conducted to confirm factorability. A KMO value above 0.60 and a significant Bartlett's test ($p < 0.05$) were considered acceptable. Factor extraction was performed using Principal Axis Factoring, and Varimax rotation was applied to achieve a clear and interpretable factor structure. Items with factor loadings below 0.50 or cross-loadings were removed. Second, reliability testing using Cronbach's Alpha assessed internal consistency. Third, Pearson correlation analysis examined the strength and direction of relationships among variables. Fourth, multiple regression analysis evaluated the predictive effects of Teacher Leadership (TL) and Competitive Intelligence Utilization (CIU) on Sustainable Educational Innovation (SEI). Finally,

regression-based path analysis was conducted to test direct and indirect relationships among variables. These analytical techniques were applied in a complementary manner, where EFA and reliability testing ensured measurement validity, correlation analysis explored initial relationships, regression analysis assessed predictive strength, and path analysis extended the model to examine mediation effects. This integrated approach ensures coherence between statistical methods and supports a comprehensive evaluation of the proposed relationships. To assess potential common method bias, Harman's single-factor test was conducted. The results indicated that a single factor did not account for the majority of variance, suggesting that common method bias was not a serious concern. Additionally, procedural remedies such as ensuring respondent anonymity and improving item clarity were applied.

Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) was used to identify the underlying factor structure of the constructs. This method helps establish construct validity by grouping related items into coherent factors and reducing data complexity while retaining meaningful variance. It helps ensure that each dimension appropriately reflects the theoretical framework, validate construct validity, and categorize related items into components. To find connections and patterns between the objects.

- Maintains significant volatility while reducing the complexity of the data.
- To make sure things load substantially onto the factors they are supposed to.
- The reliability and validity of the latter statistical Analysis are confirmed.

Reliability Testing

The internal consistency of each questionnaire concept was assessed using Cronbach's Alpha. This ensured that all measuring items under SEI, TL, and CIU properly represented their respective variables, confirming the survey instrument's dependability for further statistical analysis. Acceptable dependability is shown by Cronbach's Alpha values greater than 0.70.

- To guarantee that every item in a construct measures the same fundamental idea.
- High dependability boosts data confidence and facilitates additional statistical analysis.
- To find underperforming things that might need to be changed or eliminated.

Correlation Analysis

The strength and direction of the associations between SEI, TL, and CIU were examined using Pearson correlation coefficients. Higher leadership or intelligence

utilization ratings were linked to better innovation results, according to this investigation.

$$q = \frac{\Sigma(w_j - \bar{w})(z_j - \bar{z})}{\sqrt{\Sigma(w_j - \bar{w})^2 \Sigma(z_j - \bar{z})^2}} \quad (1)$$

In Equation 1, the correlation coefficient, denoted by q, quantifies the degree and direction of the association between two variables. The variables W and Z have individual observed values denoted by w_j and z_j, whereas the corresponding variables' mean values are represented by $\bar{w}$ and $\bar{z}$. The total of all observations is represented by the symbol Σ. The covariance between the two variables is calculated in the numerator and standardized using the product of their standard deviations in the denominator, which yields a number that usually ranges from $-1\ to\ +1$.

Correlation analysis is used to determine the direction and degree of the linear relationship between two variables. Pearson's correlation coefficient evaluates the strength and direction of the association between changes in one variable and changes in another, with values ranging from −1 (perfect negative) to +1 (perfect positive).

Multiple Regression Analysis

By measuring the influence of teacher leadership and competitive intelligence on sustainable educational innovation, regression modelling was used to assess the hypothesis. It calculated the predictive power of independent variables, demonstrating the extent to which leadership and intelligence use practices might account for diversity in innovation outcomes.

$$Z = \beta_0 + \beta_1^* W_1 + \beta_2^* W_2 + \cdots + \beta_l^* W_l + \epsilon \quad (2)$$

In Equation 2, Z stands for the dependent variable, Sustainable Educational Innovation (SEI). β_0 represents the value of Z when all independent variables are zero. β_0 is the intercept or constant. W_1, W_2,... W_l Teacher Leadership TL and CIU are examples of independent variables or predictors. The coefficients, β_1^*, β_2^*,… β_l^* show the degree and direction of each predictor's association on the dependent variable. The error term, which captures unexplained variance in the model caused by additional factors not included, is represented by the term ϵ.

4 RESULTS AND DISCUSSION

The results demonstrate that both Teacher Leadership (TL) and Competitive Intelligence Utilization (CIU) significantly influence Sustainable Educational Innovation (SEI). Regression analysis indicates that TL explains 57% of the variance in innovation-driven behaviors ($R^2 = 0.57$), highlighting its dominant role in shaping instructional innovation. Institutions that effectively utilize competitive intelligence exhibit stronger capabilities in long-term curriculum development, digital adaptability, and collaborative teaching practices, emphasizing the strategic importance of intelligence-driven decision-

making in education.

4.1 Demographic Profile of Respondents

It reviewed 98 valid responses by those teaching in secondary school (41.8%), and those teaching at higher education (58.2%). The sample consisted of 53.1% females and 46.9% males with the majority being aged 35 to 44. Most of the participants were between five and ten years old with respect to teaching experience. Such a distribution of the demographics provides the full picture of the nature of the educators and the use of competitive intelligence and sustainable educational innovation is presented in Table 1. The sample consisted of 98 educators from secondary (41.8%) and higher education (58.2%), with a balanced gender distribution and predominantly mid-career teaching experience. This distribution provides a relevant basis for examining the relationships among teacher leadership, competitive intelligence utilization, and educational innovation.

Table 1: Demographic Characteristics of Respondents

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	46	46.9
	Female	52	53.1
Age	25–34 years	28	28.6
	35–44 years	37	37.8
	45–54 years	21	21.4
	Above 55	12	12.2
Teaching Experience	< 5 years	19	19.4
	5–10 years	33	33.7
	11–15 years	24	24.5
	> 15 years	22	22.4
Institution Type	Higher Education	57	58.2
	Secondary Education	41	41.8

The Figure 3 demonstrates the demographic profile of the 98 instructors who have been polled. Although Figure 3(b) highlights the fact that most of the respondents belong to the mid-career age bracket, in Figure 3(a), there is a uniform gender representation. Most of the respondents had gained intermediate teaching experience and are linked to institutions of higher learning, as indicated in Figure 3(c) and 3(d) Institutional Affiliation of Educators. This diverse group of teachers offers a solid foundation upon which teacher leadership and educational innovation may be analyzed.

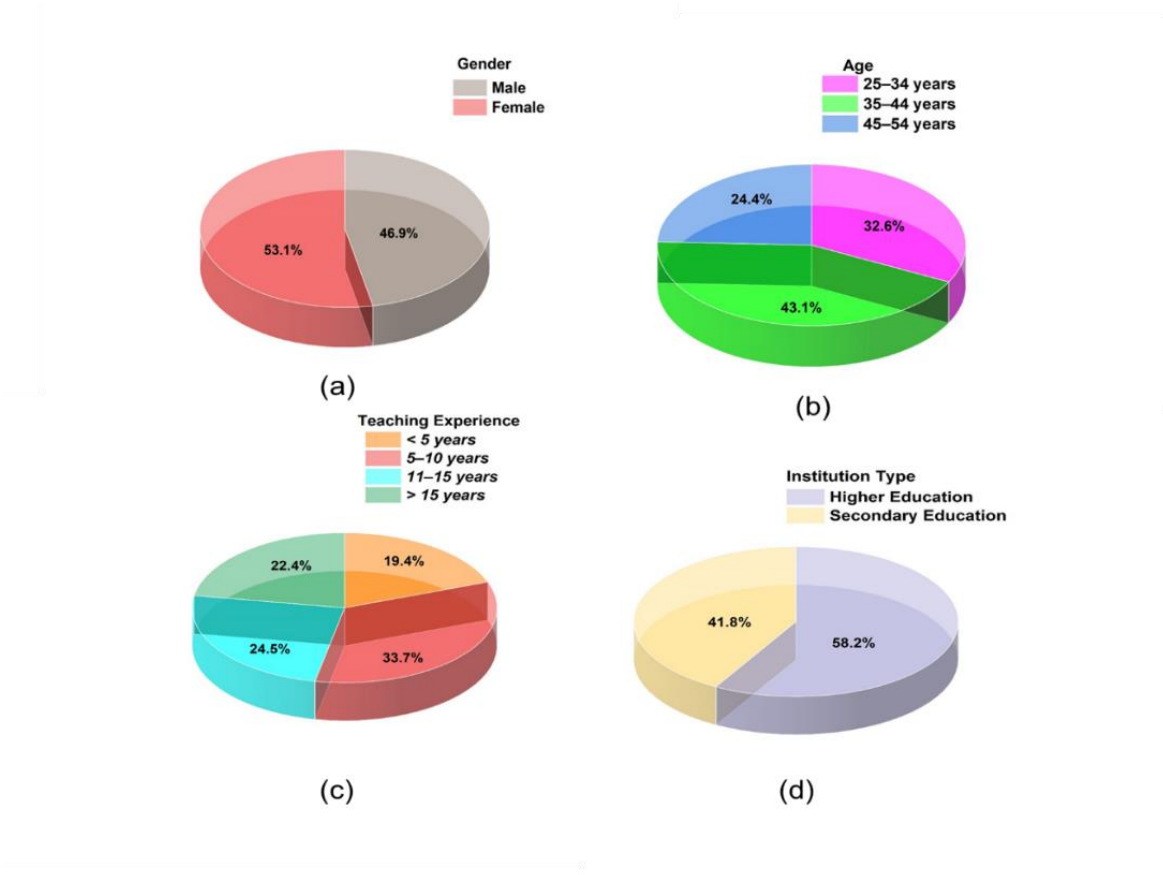

Figure 3: Characteristics Analysis of (a) Demographic Distribution by Gender, (b) age profile of Research Introducers, (c) Teaching experience Classification, (d) Institutional Affiliation of Educators.

4.2 Exploratory Factor Analysis (EFA)

The validity of the TL and CIU framework was checked with the help of EFA. Table 2 demonstrates strong correlations between the items and the constructs to which they belong with all the factor loadings exceeding 0.70. It means that the questionnaire items can accurately measure TL and CIU and ensure a specific assessment of their influence on SEI. The findings support the resilience of the measuring model and provide a solid basis on further research. Beyond confirming measurement validity, these results indicate that TL and CIU are structurally stable constructs within educational systems, suggesting that intelligence-driven practices and leadership behaviors are consistently embedded in institutional innovation processes.

Table 2: Exploratory Factor Analysis (EFA) Loadings of Constructs

Construct	Item	Factor Loading
CIU	CIU1	0.81
	CIU2	0.79
	CIU3	0.77
	CIU4	0.74
TL	TL1	0.83
	TL2	0.80
	TL3	0.78
	TL4	0.76
SEI	SEI1	0.84
	SEI2	0.82
	SEI3	0.79
	SEI4	0.77

Reliability and Validity Analysis

To guarantee accurate measurement of SEI, TL, and CIU, the constructs must be valid and reliable. Cronbach's Alpha values (0.87-0.90) show strong internal consistency, Composite dependability values (CR) above 0.85 show strong construct dependability, and Average Variance Extracted (AVE) values (0.67-0.71) show acceptable convergent validity. As shown in Table 3, these findings support the need for more research on the measurement instrument.

Table 3: Measurement Reliability and Validity of Constructs

Construct	Cronbach's Alpha	Composite Reliability (CR)	AVE
CIU	0.87	0.89	0.67
TL	0.88	0.90	0.69
SEI	0.90	0.91	0.71

In Figure 4, a structural equation model showing the connections between TL, CIU, and SEI is presented in the image. Several indicators with high factor loadings are used to measure each latent component. The high path coefficients show strong positive correlations, indicating that innovation-driven and sustained educational progress is greatly aided by teacher leadership techniques and efficient use of intelligence.

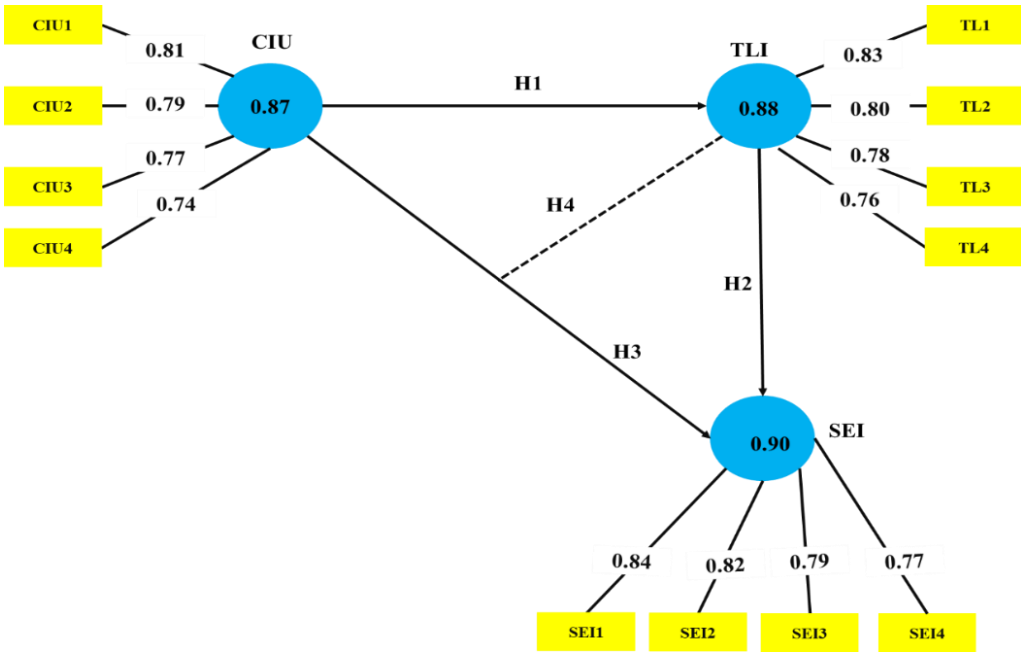

Figure 4: Structural Equation Model Showing Relationships Among Research Constructs and Measurement Indicators

4.3 Correlation Analysis

The associations between TL, CIU, and SEI were investigated using Pearson correlation analysis. All constructs have substantial positive correlations, according to the results: TL–CIU (r = 0.63), CIU–SEI (r = 0.66), and TL–SEI (r = 0.71). As stated in Table 4, these results show that increased TL and efficient use of intelligence are associated with more sustainable educational innovation, improving collaborative teaching, digital adaptation, and long-term instructional development. From a competitive intelligence perspective, these strong correlations suggest that institutions leveraging intelligence practices are more likely to develop adaptive leadership structures and innovation-oriented teaching strategies. This reinforces the role of CI as a strategic enabler of knowledge-driven decision-making in educational environments. Multiple Regression Analysis. Pearson correlation analysis shows moderate to strong positive associations among TL, CIU, and SEI (r = 0.63–0.71). These results suggest that higher levels of leadership and intelligence utilization are linked with increased educational innovation, although the relationships should be interpreted as associative rather than causal.

Table 4: Pearson Correlation Matrix Among CIU, TL, and SEI

Variables	CIU	TL	SEI
CIU	1	0.63	0.66
TL	0.63	1	0.71
SEI	0.66	0.71	1

4.4 Multiple Regression Analysis

The effect of TL and CIU on SEI was evaluated using multiple regression analysis. Both TL and CIU strongly predict SEI, as Table 5 illustrates, indicating their combined impact on innovation outcomes in secondary and higher education. These findings demonstrate the predictive ability of intelligence and leadership skills in promoting long-term instructional progress, collaborative teaching, and digital adaptability. Importantly, the higher beta value of TL (β = 0.47) compared to CIU (β = 0.41) suggests that while intelligence provides critical inputs, leadership acts as the primary mechanism through which intelligence is translated into actionable educational innovation. This highlights the mediating role of human agency in intelligence-driven systems.

Table 5: Regression Analysis of Predictors Influencing for Beta Values

Predictor	Beta (β)	t-value	p-value
CIU	0.41	4.96	<0.001
TL	0.47	5.21	<0.001

The regression findings illustrating the impact of independent variables of TL and CIU on sustainable educational innovation are displayed in Figure 5. Strong statistical significance is confirmed by high t-values, whereas beta coefficients show the positive contributions from both predictors. Both factors have a substantial impact on innovation-oriented teaching methods in digital educational environments, as shown by the p-values (<0.001).

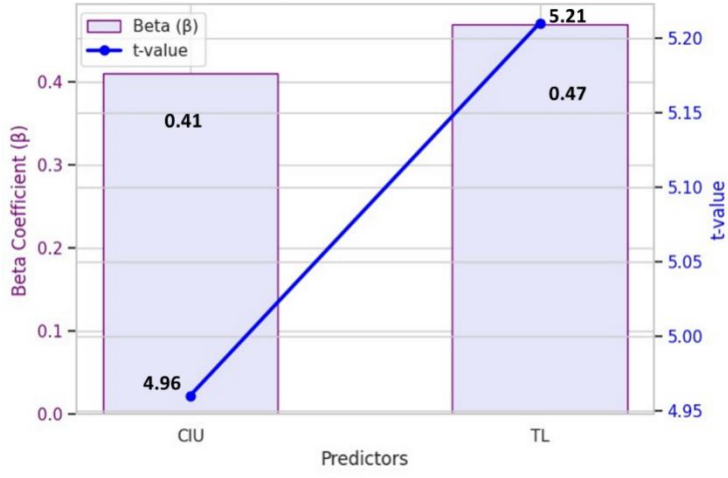

Figure 5: Regression Analysis Showing the Value of Key Predictors in Educational Research

Table 6: Model Statistics for Predicting Sustainable Educational Innovation

R	R^2	Adjusted R^2	F-value	Significance
0.75	0.57	0.56	62.41	<0.001

In Table 6, the suggested assumptions were supported by the model's good predictive power, which explained 57% of the variation ($R^2 = 0.57$).

4.5 SEM Path Analysis Results

Using regression-based route estimation in IBM SPSS Statistics version 28, path analysis was performed to investigate the suggested correlations among SEI, TL, and CIU. The findings supported the proposed model and are presented in Table 7 and reflect strong positive direct and indirect relationships between constructs. These outcomes indicate the interaction between TL as a mediator and the interaction between intellect and leadership styles to foster long-term educational innovation. These findings contribute to the competitive intelligence (CI) literature by extending its application beyond corporate and strategic management contexts into educational systems. Specifically, the results demonstrate that CIU not only directly influences innovation outcomes but also indirectly enhances them through leadership mechanisms. This positions competitive intelligence as a critical driver of institutional adaptability, strategic foresight, and sustainable innovation in education. However, alternative explanations should be considered. The strong effect of Teacher Leadership (TL) may not solely result from competitive intelligence utilization but could also reflect institutional culture, prior digital readiness, or leadership autonomy within educational systems. This suggests that while CIU provides informational inputs, contextual organizational factors may influence how effectively such intelligence is translated into innovation outcomes.

Importantly, this study contributes to the conceptual development of competitive intelligence by positioning it as a dynamic capability within educational institutions. Unlike traditional views of CI as information gathering, the findings demonstrate that its value emerges through its integration with leadership processes, enabling sense-making, strategic alignment, and adaptive decision-making in complex learning environments. This shifts the discussion from ‘data usage’ to ‘intelligence utilization,’ emphasizing that competitive intelligence involves not only access to data but also the organizational capability to interpret, apply, and transform that knowledge into sustainable innovation.

Table 7: Hypothesis Testing and Path Coefficients

Hypothesis	Path	Beta (β)	t-value	Result
H1	CIU → TL	0.63	7.18	Supported
H2	TL → SEI	0.47	5.21	Supported
H3	CIU → SEI	0.41	4.96	Supported
H4	CIU → TL → SEI (Indirect Effect)	0.30	3.88	Supported

Figure 6 represents the relationships between CIU, TL and SEI in the form of a structural equation in the image. Several observable indicators with high factor loadings are used to represent each latent construct. The concept emphasizes how good use of intelligence fosters teacher leadership, which in turn supports innovative and sustainable teaching methods.

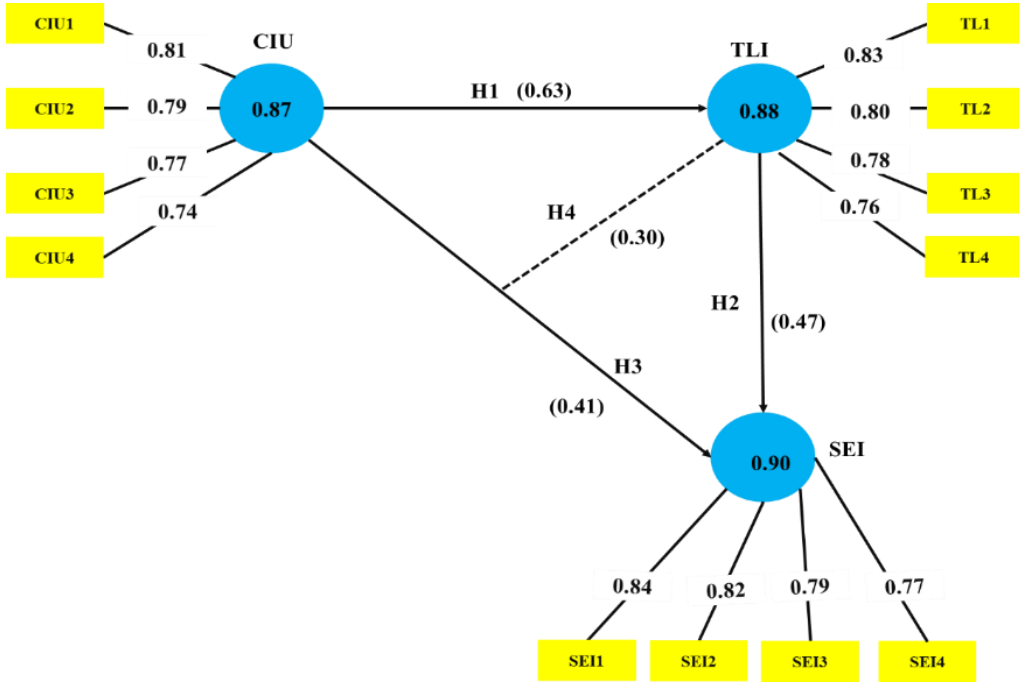

Figure 6: Path Model Representing Relationships Between Research Variables and Indicators

The standardized coefficients of the two direct pathways (0.63 × 0.47 = 0.30) were multiplied to determine the mediation effect. The association between the use of competitive intelligence and sustainable educational innovation is somewhat mediated by teacher leadership, according to the indirect path's significant t-value of 3.88 ($p < 0.01$).

5 FINAL CONSIDERATIONS

Prior research findings highlight the expanding relevance of digital and AI-driven platforms, information management, and digital leadership in fostering sustainability, efficiency, and innovation. However, there are a number of restrictions. Allam et al. (2025) limited empirical validation by mostly relying on theoretical debate in the absence of primary evidence. Qiao & Hong (2024) reduced generalizability by using limited, sector-specific samples. Küçükuncular & Ertugan (2025) limited the empirical range by

concentrating on case studies. Zada et al. (2025) did not practically apply their findings in the real world because they primarily analyzed secondary data. Strongness was also reduced because Amin and Khan (2024) did not provide quantitative validation. Collected primary data comprised of 98 educators working in secondary and higher education institutions and, due to the combination of TL and CIU, this study helps fill these gaps and provide the results that both confirm and elaborate the conclusions of the previous studies. The results indicate that systematized CIU and effective TL have a significant positive effect on SEI. This study demonstrates improved adaptability to the long term, team teaching, and digital innovation in learning settings, which experimentally confirmed the positive advantages of leadership and intelligence application as compared to prior studies.

The connection between TL and the implementation of CIU and long-term innovation in education was researched. The collection of primary data was conducted through standardized digital surveys which they completed. 98 educators in secondary and higher learning institutions filled out the questionnaires. The accuracy and validity of concepts was guaranteed by the reliability testing, and exploratory data analysis. Correlation and multiple regression analyses showed that TL (0.47, $p < 0.001$) and CIU (0.41, $p < 0.001$) predict innovation results significantly. Co-located as a sustainable education innovation is the combination of leadership and intelligence, which is evidenced by higher rates of collaborative teaching innovation, digital adaptation, and long-term improvement of instruction reported by higher educational institutions with well-organized intelligence practices and effective leadership. To enhance TL and CIU and to enhance education innovation in a range of educational settings in the long run, future research explores the combination of state-of-the-art digital tools and AI-based analytics.

Funding Project: Sichuan International Studies University's 2025 University-level Research Project "Research on the Model and Path for Constructing Digital Literacy of Ideological and Political Course Teachers in Colleges and Universities from the Perspective of Digital Intelligence" (Project No.: sisu202531).

REFERENCE

Adeoye, M. A., Oladimeji, R. M., & Paramole, O. C. (2024). 21st century leadership as a catalyst for sustainable reform: Transformative practices in digital education. Eduvis: Jurnal Manajemen Pendidikan Islam, 9(2), 61–86. https://doi.org/10.47453/eduvis.v9i2.3264

Alhawamdeh, H., Alkhawaldeh, B. Y., Zraqat, O., & Alhawamdeh, A. M. (2024). Leveraging business intelligence in organizational innovation: A leadership perspective in commercial banks. International Journal of Academic Research in Accounting, Finance and Management Sciences, 14(1), 295–309. https://doi.org/10.6007/IJARAFMS/v14-i1/20399

Allam, H. M., Gyamfi, B., & AlOmar, B. (2025). Sustainable innovation: Harnessing AI and living intelligence to transform higher education. Education Sciences, 15(4), 398. https://doi.org/10.3390/educsci15040398

Freser, J. (2025). Innovative approaches to educational management in the digital era. Alacrity: Journal of Education, 1119–1128. https://doi.org/10.52121/alacrity.v5i3.890

Hussein, H., Albadry, O. M., Mathew, V., Al-Romeedy, B. S., Alsetoohy, O., Abou Kamar, M., & Khairy, H. A. (2024). Digital leadership and sustainable competitive advantage: Leveraging green absorptive capability and eco-innovation in tourism and hospitality businesses. Sustainability, 16(13), 5371. https://doi.org/10.3390/su16135371

Isbahi, M. B. (2023). Optimizing educational leadership: Building sustainable education in the 5.0 era. Anjasmoro: Islamic Interdisciplinary Journal, 1(1), 43–66. https://doi.org/10.69965/anjasmoro.v1i1.18

Jiménez-Partearroyo, M., & Medina-López, A. (2024). Leveraging business intelligence systems for enhanced corporate competitiveness: Strategy and evolution. Systems, 12(3), 94. https://doi.org/10.3390/systems12030094

Küçükuncular, A., & Ertugan, A. (2025). Teaching in the AI era: Sustainable digital education through ethical integration and teacher empowerment. Sustainability, 17(16), 7405. https://doi.org/10.3390/su17167405

Mogas, J., Palau, R., Fuentes, M., & Cebrián, G. (2022). Smart schools on the way: How school principals from Catalonia approach the future of education within the fourth industrial revolution. Learning Environments Research, 25(3), 875–893. https://doi.org/10.1007/s10984-021-09398-3

Mushadi, M., Usman, N., & Bahrun, B. (2025). Empowering teachers in the digital age: Leadership strategies for enhancing pedagogic competencies in high schools. Journal of Educational Management and Learning, 3(1), 32–43. https://doi.org/10.60084/jeml.v3i1.254

Mustari, M., & Nurhayati, S. (2024). Multifaceted instructional leadership of school principals to improve student character in the digital era. Al-Hayat: Journal of Islamic Education, 8(2), 488–504. https://doi.org/10.35723/ajie.v8i2.459

Peng, B. (2022). Digital leadership: State governance in the era of digital technology. Cultures of Science, 5(4), 210–225. https://doi.org/10.1177/2096608321989835

Qiao, G., Li, Y., & Hong, A. (2024). The strategic role of digital transformation: Leveraging digital leadership to enhance employee performance and organizational commitment in the digital era. Systems, 12(11), 457. https://doi.org/10.3390/systems12110457

Quaicoe, J. S., Ogunyemi, A. A., & Bauters, M. L. (2023). School-based digital innovation challenges and way forward: Conversations about digital transformation in education. Education Sciences, 13(4), 344. https://doi.org/10.3390/educsci13040344

Rasdiana, Wiyono, B. B., Imron, A., Rahma, L., Arifah, N., Azhari, R., & Maharmawan, M. A. (2024). Elevating teachers' professional digital competence: Synergies of principals' instructional e-supervision, technology leadership, and digital culture for educational excellence in the digital-savvy era. Education Sciences, 14(3), 266. https://doi.org/10.3390/educsci14030266

Salīte, I., Fjodorova, I., & Ivanova, O. (2024). Teacher education and leadership for a sustainable world. Journal of Teacher Education for Sustainability, 26(2), 1–5. https://doi.org/10.2478/jtes-2024-0013

Supriadi, E. (2025). The influence of digital leadership on teacher performance through digital literacy competence in the era of digital education transformation. Journal of English Language and Education, 10(6), 180–192. https://doi.org/10.31004/jele.v10i6.1669

Surohmat, D. S., & Firdaus, R. (2025). Digital transformation of teacher leadership: Innovative strategies for increasing the quality of primary and secondary education. Jurnal Evaluasi dan Pembelajaran, 7(2), 105–118. https://doi.org/10.52647/jep.v7i2.379

Ul Amin, N., & Khan, M. A. (2024). Driving competitive advantage in the digital era: The role of dynamic capabilities, innovation, and leadership. Dinasti International Journal of Economics, Finance & Accounting (DIJEFA), 5(5). https://doi.org/10.38035/dijefa

Zada, M., Zada, S., Dhar, B. K., Ping, C., & Sarkar, S. (2025). Digital leadership and sustainable development: Enhancing firm sustainability through green innovation and top management innovativeness. Sustainable Development, 33(5), 6704–6716. https://doi.org/10.1002/sd.3488