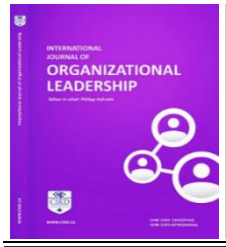

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# The Adoption of Blockchain Technology in Higher Education: The Impact of Leadership Readiness

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## ABSTRACT

The emergence of blockchain technology has captured considerable interest across various industries due to its ability to revolutionize traditional systems by ensuring enhanced security, transparency, traceability and efficiency. More recently, the higher education sector has begun exploring the adoption of blockchain technology, acknowledging its potential to transform multiple facets of the educational landscape, including academic administration, the learning and teaching process, and academic research. The primary goal of this study is to ascertain the factors that influence individuals' behavioral intention to adopt and use blockchain-based educational platforms. Moreover, the research aims to underscore the pivotal role played by educational leadership in advancing the adoption of blockchain technology within higher education institutions. Blockchain technology is recognized as a cutting-edge solution that has the potential to streamline processes, reduce costs, and foster trust within the educational ecosystem. A novel conceptual model based on the Unified Theory of Acceptance and Use of Technology (UTAUT) was developed and tested for the purpose of this study. Data was gathered from 175 respondents across eight European countries through a structural questionnaire. Partial least squares structural equation modeling (PLS-SEM) was employed to examine the hypotheses of the model. The study unveils perceived trust as the primary determinant influencing the behavioral intention to use blockchain-based educational solutions, underscoring its pivotal role in embracing innovative technologies by instilling confidence and reducing uncertainty among users. Furthermore, educational partner readiness, performance expectancy, and effort expectancy also have a positive impact on the usage intention. Additionally, the results also highlight the significance of leadership blockchain readiness in shaping the actual usage behavior. The findings offer valuable insights into the adoption of blockchain technology in higher education. Also, the study extends previous research by utilizing an extended UTAUT framework, and it contributes to the emerging literature on blockchain implementation and technology acceptance models.

In today's rapidly evolving world, innovation has emerged as a crucial catalyst for growth and transformation across various industries. The education sector, which was once characterized by conventional classroom setups and traditional teaching approaches, is now witnessing a pressing need for innovation to align with the requirements of a digitally connected society. Although many educational institutions have made progress in adopting digital tools, a significant portion of the sector continues to operate within outdated frameworks. The reliance on traditional administrative processes, opaque data storage systems, and challenges in verifying academic credentials pose obstacles to efficient educational operations (Benavides et al., 2020; Han et al., 2018; Saykili, 2019).

As educational institutions face the complexities of equipping learners for an unpredictable future, they increasingly recognize the advantages of emerging technologies (Mohamad Ali et al., 2022). Among these technologies, blockchain is a transformative technology capable of reshaping the educational landscape. Blockchain can provide a platform for innovation, utilizing a tamper-resistant and decentralized system to manage and validate educational records, certificates, and credentials (Raimundo & Rosário, 2021). As the field of education stands at the cusp of a digital transformation, blockchain adoption offers significant potential for establishing a more effective, transparent, and learner-focused system. However, the successful integration of blockchain technology in education relies on visionary leadership capable of navigating the intricacies associated with blockchain innovation. Educational leaders play a vital role in creating an environment that embraces change and fosters experimentation, which facilitates the adoption of emerging technologies (Richard et al., 2022).

Given the relatively novel research topic centered on the adoption of blockchain technology in education, it is important to highlight several research gaps that exist within this domain. Firstly, there is a lack of a widely applicable adoption model that educational leaders can consider to accelerate blockchain-driven innovation. Additionally, there is a scarcity of empirical studies focusing on blockchain adoption in education within the relevant literature. Furthermore, to our knowledge, no studies have been conducted to examine the factors that influence the adoption of blockchain-based educational platforms across European countries. Therefore, this paper aims to contribute to the ongoing discussion about blockchain adoption by introducing a fresh theoretical perspective. The primary objective is to acquire an in-depth understanding of the factors driving the utilization of blockchain-driven educational platforms while also highlighting the significance of leadership in fostering digital transformation. The novelty of this research lies in the development of an extended conceptual model that builds upon the Unified Theory of Acceptance and Use of Technology (UTAUT). This model also incorporates relevant constructs within the realm of education.

The structure of this research paper is outlined as follows: the introduction presents the objectives of the study and identifies the research gaps, providing a comprehensive overview of the entire research. The second section provides an extensive literature review of the concept of blockchain technology with a particular focus on education, the benefits and challenges, as well as current applications. The subsequent section focuses on the design of the conceptual model, encompassing the identification of factors influencing the intention to use and the usage behavior of blockchain-driven platforms in education, along with the development of research hypotheses. The next section introduces the research methodology, followed by the analysis of

the results. The last two sections of the paper are dedicated to the general discussion, implications for theory and practice, limitations, and avenues for future research, as well as conclusions.

## Theoretical Background

### *Blockchain Technology in Education*

Blockchain technology is considered a groundbreaking technological advancement that has the potential to revolutionize how institutions store and utilize data. At its core, a blockchain is a decentralized database consisting of records that are distributed across computational nodes and arranged as a linked list of chronologically ordered blocks. Each block contains information that is cryptographically hashed. Proponents of blockchain perceive it as a foundational element for trustless transactions, opening up numerous possibilities for secure and convenient value transfer among participants (Gad et al., 2022).

As a disruptive technology, blockchain brings forth a range of benefits, including automation, efficiency, cost reduction, transparency, trust, provenance, non-repudiation, and enhanced security (Kimani et al., 2020). One of the key advantages of blockchain technology is its ability to securely develop, store, and share sensitive data records online, providing instant verification in a secure manner. By eliminating the need for a central authority, blockchain enables data sharing among organizations within an ecosystem, reducing the reliance on intermediaries. This decentralized structure ensures efficient operations at a minimal cost while also mitigating information asymmetries. Furthermore, blockchain's resilience to centralized database outages makes it a robust and reliable solution (Hughes et al., 2019).

Blockchain technology replaces human trust with technology-enabled verification through protocols and consensus mechanisms (Hughes et al., 2019). Non-repudiation ensures the integrity of transaction history, as all transactions are time-stamped and permanently recorded, preventing participants from refuting or disputing their actions. This enables secure and reliable audit trails over time. Additionally, complex mathematical algorithms guarantee data authenticity, ensuring tamper-proof and transparent records (Niranjanamurthy et al., 2018).

The integration of blockchain technology in the education sector represents significant progress in the domain of emerging technologies. At present, educational institutions encounter challenges in managing and verifying student records and credentials due to outdated centralized systems (Han et al., 2018). These traditional systems also raise concerns regarding data security and privacy. However, blockchain technology offers solutions to these challenges by organizing sensitive data, ensuring record authenticity and accuracy, and addressing concerns related to secure data storage. It adopts a decentralized approach and promotes efficient record-keeping in a student-centric manner. Additionally, blockchain enables secure access, eliminates the need for third-party intermediaries in certificate generation, and ensures transparency (Raimundo & Rosário, 2021; Ramos & Queiroz, 2022). Through blockchain implementation, educational institutions can establish a tamper-resistant system that enhances data security, improves operational efficiency, and fosters trust among participants.

Blockchain technology offers significant benefits to the education sector, including enhanced security, lower costs, improved trust and transparency, and efficient data management. Blockchain provides a secure platform for sharing students' data and verifying academic credentials. The use of cryptographic hashes and signatures ensures the reliability of transactions and protects the integrity of learning records. By reducing storage and transaction

costs, blockchain helps to minimize the financial burden on educational institutions. It also facilitates better control of data access and improves accountability and transparency in the management of educational records. Furthermore, blockchain technology significantly improves students' records management efficiency by streamlining data management and enabling efficient data exchange. Additionally, it empowers learners to make informed career decisions through seamless record exchange, fostering interactivity between educational institutions and employment agencies (Alammary et al., 2019; Bhaskar et al., 2020).

Educational institutions can benefit from the advantages of blockchain technology in various domains. One area of applicability is digital credentials, where blockchain can ensure the verification of qualifications and their authenticity. Through interoperable and secure record-keeping, blockchain enhances the management of certificates, making it more efficient and reliable. Additionally, blockchain technology plays a significant role in the protection of intellectual property rights. Its decentralized and immutable nature helps to establish ownership and protect the originality of intellectual property within the education sector. Moreover, educational institutions can leverage blockchain in decentralized learning platforms that offer a transparent system for tracking student progress and credentials. Blockchain also streamlines the management of student exchange programs by eliminating bureaucratic and cumbersome processes, making it easier for students to participate and institutions to coordinate. Lastly, in the context of academic publication, blockchain provides a transparent peer review process and immutable publication records, ensuring the integrity and authenticity of scholarly works while promoting open access and collaboration within the academic community (Kamišalić et al., 2019; Mohammad & Vargas, 2022).

Despite the potential benefits of blockchain technology for educational institutions, its widespread adoption may face several challenges. Blockchain technology is still considered to be in its early stages of development and not yet fully matured. The large volumes of student data may pose challenges in processing and verifying records, leading to longer processing times and increased power consumption. Also, the limited interoperability among different blockchain networks and integration challenges with existing legacy systems may further impede adoption. Additionally, a shortage of skilled blockchain engineers and experts makes it difficult to develop secure and reliable blockchain education platforms. Addressing these challenges and increasing stakeholder awareness is crucial for successfully integrating blockchain in education (Ma & Fang, 2020; Mohammad & Vargas, 2022).

## *Current Blockchain Applications in Education*

Despite still being in the early stages of development, some higher education institutions are actively exploring the potential of blockchain technology to facilitate digital transformation. Most of these applications have been directed towards the verification of academic credentials, such as degrees and certificates, to combat the issue of counterfeit credentials. Table 1 presents a summary of seven blockchain-based platforms in education.

**Table 1**

*Blockchain-based Platforms in the Education Sector*

| No. | Platform | Description |
|---|---|---|
| 1. | Blockcerts | Blockcerts, a blockchain-based platform developed in partnership between Learning Machine and MIT Media Lab, allows institutions to issue tamper-proof digital certificates that offer recipients more control over their credentials, eliminating the need for third-party verification (Ma & Fang, 2020). |
| 2. | Disciplina | Disciplina is a blockchain-based platform that creates a unified registry of academic achievements and qualifications for universities. It automatically assigns scores based on students' achievements, allowing universities to develop personalized learning plans and track their academic history (Disciplina, 2023). |
| 3. | Educhain | Educhain is a blockchain platform revolutionizing the issuance, verification, and distribution of digital academic credentials. It offers a secure digital wallet for students to manage their credentials and provides employers with a reliable method to verify their authenticity (Educhain, 2023). |
| 4. | EduCTX | EduCTX is a credit and grading blockchain-based platform that uses tokens to represent completed credits in students' records, creating a unified and trusted system for higher education organizations (Raimundo & Rosário, 2021). |
| 5. | Hyland Credentials | Hyland Credentials is a provider of blockchain-secured digital records that offer a complete system for issuing official records and enabling instant verification globally (Hyland Credentials, 2023). |
| 6. | ODEM | ODEM is the first blockchain education platform built on Ethereum, enabling direct connections between students, educators, and employers, allowing students to create customized learning plans and credentials that can be shared with employers (ODEM, 2023). |
| 7. | Parchment | Parchment is a blockchain platform that streamlines the issuance of credentials, review academic merit, and issuance of diplomas. It also facilitates student mobility through simplified course sharing, credit transfer, and academic records processing (Parchment, 2023). |

## Technology Adoption models

Economists widely recognize that technological advancements have been pivotal in driving economic growth, especially since the Industrial Revolution era. In the context of education, the integration and adoption of new technologies have been extensively studied, with a focus on innovations in teaching methods and learning processes. These technological advancements have the potential to revolutionize educational practices, leading to improved learning outcomes and increased access to quality education.

Several theories and models have been developed to understand technology adoption in education (Abbad, 2021; Hiran & Henten, 2020), including the Technology Acceptance Model, Diffusion of Innovation Theory, Technology, Organization, and Environment Framework, and Unified Theory of Acceptance and Use of Technology. These theories place a strong emphasis on understanding the psychological and behavioral aspects of technology users in educational settings. However, each theory has its own limitations, including the use of various terminologies and the challenges in fully capturing all influencing factors due to the complexity and diversity of the analyzed behaviors.

In this context, Venkatesh and his research team conducted a comparative evaluation of eight technology acceptance models and theories, including the Theory of Reasoned Action (TRA), the Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), a model combining TAM and TPB (C-TAM-TPB), Innovation Diffusion Theory (IDT), Model of PC Utilization (MPCU), Motivational Model (MM), and Social Cognitive Theory (SCT). The researchers examined 32 variables from these frameworks, identifying common traits, and proposed a new comprehensive theory called the Unified Theory of Acceptance and Use of Technology (UTAUT), which consolidates the unique aspects of all eight theories and models. The UTAUT model highlights three crucial factors that influence behavioral intention: performance expectancy, effort expectancy, and social influence (Venkatesh et al., 2003). Performance expectancy relates to how well the technology meets users' expectations and enhances their performance. Effort expectancy considers users' perceptions of the ease of use of

the technology, while social influence explores how others can influence an individual's acceptance and usage of the technology. The model also includes two primary drivers for usage behavior: behavioral intention and facilitating conditions. Behavioral intention pertains to an individual's deliberate intention to use the technology, whereas facilitating conditions encompass the assistance and resources offered by the organizational and technical infrastructure to facilitate its usage. To increase the model's predictive power, moderating variables such as age, gender, voluntariness of use, and experience were also proposed (Pieters et al., 2022).

The UTAUT model provides a comprehensive framework for understanding the acceptance and usage of novel technologies. It offers insights into both the acceptance and actual usage of these technologies, outperforming the other eight technology acceptance frameworks in terms of predictive capabilities. The UTAUT model can explain up to 70% of the variation in the behavioral intention construct and approximately 50% of the variation in technology usage (Venkatesh et al., 2003). However, subsequent research has identified certain limitations, such as the insignificance of moderators like age, experience, gender, and voluntariness (Kabir et al., 2021). Other researchers have also observed that many studies only utilize a subset of the factors in the conceptual model, excluding the aforementioned moderators. Therefore, while UTAUT has a high explanatory power, its applicability should be evaluated based on the research goals and contextual factors specific to each study.

## The Role of Leadership in Innovation

In the rapidly changing world, the role of leadership in driving innovation has become increasingly important across various sectors (Argelich, 2017), including education. Embracing emerging technologies like blockchain requires strong leadership to navigate the dynamic digital landscape and meet the challenges of the digital era. The impact of digital transformation on education is profound, influencing students' learning journeys while putting an emphasis on the development of skills necessary for the digital age. Consequently, higher education institutions must adapt their procedures to align with the global trend of digital transformation (Niță & Guțu, 2023).

To align with the global trend of digital transformation, higher education institutions must adapt their procedures with a particular focus on the seamless integration of humans with technology through information and communication technology. This paradigm shift has significant implications for the management systems of educational institutions. Human resources in these institutions play a vital role as technological advancements require the development of competencies to harness these advancements effectively. Educational leaders must mobilize human resources effectively and create an environment that embraces change to capitalize on the potential benefits of disruptive technologies (Prestiadi et al., 2019).

Educational Leadership in the era of digital transformation should be characterized by 21st-century competencies, including critical thinking, collaboration, communication, creativity, innovation, global connections, and proficiency in technology and learning tools (Prestiadi et al., 2019). Digital leaders ought to embrace a dynamic, collaborative, and inclusive approach, prioritizing innovation and actively involving teams from all hierarchical levels to swiftly adapt to changing circumstances and drive progress (Oberer & Erkollar, 2018). Additionally, educational leaders should also act as agents of change capable of shaping the direction of their

institutions. At the same time, they serve as professional coaches and mentors, fostering the development of their educational communities.

Within this digital environment, a new leadership style, digital transformational leadership, emerges, significantly influencing institutional innovation absorption capability and performance. Educational leaders play a pivotal role in creating a compelling vision fostering a culture of innovation that encourages experimentation and empowering academic staff and students to explore the transformative potential of blockchain technology. Additionally, educational leaders need to understand the technical intricacies and build collaborative networks with experts and research organizations to develop digital competencies that facilitate blockchain integration (Niță & Guțu, 2023).

Previous research has also demonstrated that top management support in the adoption of blockchain technology is undeniably crucial, as it involves the understanding and active involvement of leadership in accepting and implementing this disruptive technology (Hashimy et al., 2022). Leadership support provides the necessary direction, resources, and funding to motivate the organization to overcome resistance and successfully integrate emerging technologies into existing processes (Nayal et al., 2023).

The integration of blockchain technology in education will have a profound impact on the future of the sector, providing a strong and secure framework for various applications, particularly in academic record management, digital credentials, decentralized learning environments, protection of intellectual property rights, academic publication, and facilitation of student exchanges. The significance of leadership in fostering innovation cannot be overstated, as it plays a crucial role in preparing institutions for the transformative possibilities of blockchain technology. Without proactive leadership and adaptation to the digital landscape, the rapid adoption of blockchain technology may be impeded (Richard et al., 2022).

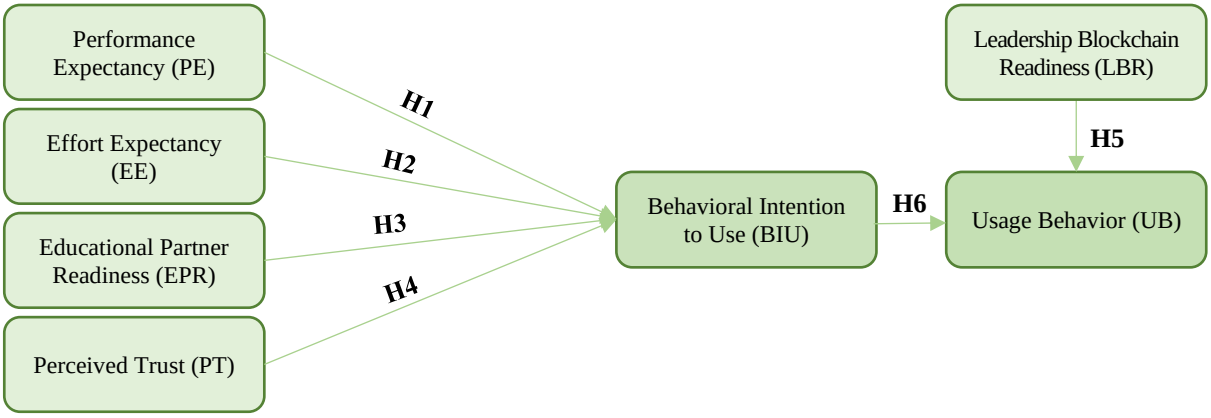
## Design of the Conceptual Model and Hypothesis development

This research introduces a new conceptual model based on the Unified Theory of Acceptance and Use of Technology Model (UTAUT) to analyze and evaluate the factors impacting the adoption of blockchain technology in education. The proposed model takes a novel theoretical approach by modifying and expanding the original UTAUT model. Additionally, it overcomes previous limitations by excluding moderating variables like age, gender, experience, and voluntariness of use, which were found to have no significant impact in previous empirical studies.

The suggested conceptual model integrates elements drawn from existing research on technology adoption, but it was adapted to suit the specific circumstances of the education sector. Moreover, the model takes into account the particular traits and expectations of the intended audience, consisting of educational leaders from eight European nations.

Consequently, the initial UTAUT model was enriched by incorporating three novel constructs: Educational Partner Readiness, Perceived Trust, and Leadership Blockchain Readiness. The addition of these novel constructs intends to improve the model's capacity to capture the intricacies of the educational domain, thus enhancing its practicality. Figure 1 visually portrays the suggested conceptual model, depicting the connections between the different constructs and their expected influence on the behavioral intention to adopt and the actual usage of blockchain-based educational platforms.

**Figure 1**
*Proposed Conceptual Model*




The selected constructs in this research, combined with the expected relationships drawn from previous literature on technology adoption, form the basis for the proposed hypotheses, which are elaborated further below.

## Performance Expectancy (PE)

Performance expectancy pertains to the extent to which an individual believes that implementing a particular system or technology will enhance their performance (Pieters et al., 2022). In the context of this study, performance expectancy specifically refers to the level of confidence educational leaders have in using blockchain technology for educational purposes and its potential to improve the overall performance of academic processes. Several empirical studies consistently indicate that performance expectancy significantly influences the intention to adopt blockchain technology (Abu Afifa, 2022; Fosso Wamba & Queiroz, 2019; Pieters et al., 2022). Based on this, we propose the following hypothesis:

***$H_1$:*** *Performance expectancy (PE) has a positive impact on the behavioral intention to use blockchain in education (BIU).*

## Effort Expectancy (EE)

Efforts expectancy refers to the assessment of the user-friendliness of a particular system (Alazab et al., 2020). In the context of our conceptual model, the ease of utilizing blockchain-based educational platforms can also be evaluated based on the time and effort required from users. Thus, it can be argued that if educational leaders perceive blockchain-based educational platforms as requiring minimal effort and being user-friendly, they are more likely to adopt them. The influence of effort expectancy on the intention to adopt blockchain has been consistently supported by other research studies (Abu Afifa et al., 2022; Fosso Wamba & Queiroz, 2019; Pieters et al., 2022). Building on these findings, we propose the following hypothesis:

***$H_2$:*** *Effort expectancy (EE) has a positive effect on the behavioral intention to use blockchain in education (BIU).*

## Educational Partner Readiness (EPR)

Educational Partner Readiness, adapted from the social influence construct in the original UTAUT model, emphasizes the vital role of educational partners in facilitating the successful adoption of blockchain technology in education. It refers to the preparedness displayed by educational partners to embrace new technology, including their willingness to adopt blockchain and their ability to integrate it into their operational processes, which significantly influences the effectiveness and efficiency of blockchain deployment (AL-Ashmori et al., 2022). Strong collaboration and interaction among educational partners are crucial for effectively utilizing blockchain technology in education. Insufficient technical and financial resources among partners can hinder the adoption of an inter-organizational system, affecting an organization's ability to adopt blockchain technology (Malik et al., 2020).

In previous empirical research, it has been consistently proved that partner readiness plays a crucial role in ensuring the seamless implementation and successful adoption of blockchain technology. For instance, AL-Ashmori et al. (2022) emphasized partner preparedness as the most influential factor impacting blockchain adoption. Also, Malik et al. (2020) and Kamble et al. (2021) revealed that partner readiness significantly influences the intention to adopt blockchain technology. Based on these findings, we put forth the following hypothesis:

***$H_3$:*** *Educational partner readiness (EPR) positively influences the behavioral intention to use blockchain in education (BIU).*

## Perceived Trust (PT)

Trust is defined as the willingness to embrace novel and potentially risky concepts. In the context of blockchain adoption, perceived trust relates to confidence in accepting a disruptive technology (Khazaei, 2020). Trust serves as a fundamental element that instills assurance and reduces uncertainty when individuals consider embracing a new technology. With blockchain, trust dynamics shift from relying on third-party institutions to trusting the technology itself, as the behaviors of students and academic staff will be recorded and monitored on the blockchain (Chen et al., 2018).

Previous research results show that trust significantly impacts individuals' intention to adopt blockchain technology. The degree to which individuals trust both the technology and the involved entities has a substantial influence on their willingness and enthusiasm to engage with blockchain (Abu Afifa et al., 2022; Jena, 2022; Khazaei, 2020). This is particularly relevant for new or less tech-savvy users, as initial trust plays a vital role in their decision to embrace innovative technologies like blockchain (Jena, 2022). Therefore, we propose the following hypothesis:

***$H_4$:*** *Perceived Trust (PT) has a positive impact on the behavioral intention to use blockchain in education (BIU).*

## Leadership Blockchain Readiness (LBR)

The Leadership Blockchain Readiness construct evaluates how well-prepared educational leaders are in embracing new technologies and adapting the organizational culture, resources, structures, and procedures for the expected change. Leadership plays a vital role in making informed business decisions and fostering an innovative organizational mindset to ensure the successful adoption of blockchain technology, which extends beyond technical considerations (Toufaily et al., 2021). The

readiness level also involves the ability of educational leaders to efficiently allocate resources and ensure the necessary IT knowledge and experience for successful blockchain implementation. Prioritizing technological infrastructure, skilled personnel, and adequate funding is crucial for the smooth adoption of blockchain technology (Jameel & Alheety, 2022).

Previous research emphasizes the significance of managerial commitment and support, along with blockchain knowledge, in facilitating the adoption of blockchain technology and overcoming potential barriers. Misunderstanding the value of blockchain, poor leadership styles, and lack of knowledge have been identified as major obstacles to successful blockchain implementation (Chavalala et al., 2022; Rejeb et al., 2022; Toufaily et al., 2021). Based on these findings, we anticipate that higher education institutions are more likely to embrace blockchain-based platforms when their leadership is well-prepared and when they prioritize blockchain as a strategic imperative. Furthermore, personnel with blockchain expertise and sufficient financial and technical resources further contribute to the likelihood of adoption. Therefore, we formulate the following hypothesis:

***$H_5$:*** Leadership *Blockchain Readiness (LBR) positively affects the behavioral intention to use blockchain technology in education (BIU).*

### *Behavioral Intention to Use (BIU)*

Social scientists have extensively researched users' inclinations to adopt novel technologies through behavioral intention, which pertains to an individual's personal belief and subjective probability of using a particular technology in the future (Khazaei, 2020). Prior empirical studies have consistently revealed that behavioral intention predicts actual usage behavior. Studies by Ajzen (1991) and Venkatesh et al. (2003) provide compelling evidence of the significant impact of behavioral intention on usage behavior.

Considering the benefits of blockchain in education, such as enhanced data transparency, efficiency, and improved data security, the relationship between behavioral intention and actual usage is of particular importance in the proposed model. This is especially relevant given the administrative constraints faced by educational institutions. Consequently, the following hypothesis has been formulated based on these considerations:

***$H_6$:*** *Behavioral Intention to Use (BIU) blockchain in education is positively correlated with actual Usage Behavior (UB).*

## Method

### *Measurement Items*

A survey containing 22 measurement items was used to evaluate the constructs incorporated in the proposed extended UTAUT model. Respondents rated the items on a Likert scale from one to seven, indicating their level of agreement or disagreement, with one being "strongly disagree" and seven being "strongly agree". Participants were encouraged to base their responses on their personal knowledge and expertise, knowing that there were no right or wrong answers and that their inputs would be exclusively utilized for academic research purposes. Table 2 displays the collection of constructs and corresponding measurement items, along with the academic references from which these items were sourced.

**Table 2**

*Constructs and Measurement Items*

| Construct | Measurement Item | Sources |
|---|---|---|
| PE | PE1: Utilizing blockchain technology in education would enhance the efficiency of my educational institution.<br>PE2: Implementing blockchain technology in education would allow my educational institution to achieve cost efficiencies.<br>PE3: Blockchain technology would be beneficial in streamlining the educational process. | Davis (1989); Venkatesh et al. (2003); Godoe & Johansen (2012) |
| EE | EE1: Learning how to operate blockchain-based solutions in the educational context would be easy for my institution.<br>EE2: Usage of blockchain platforms would be understandable and clear.<br>EE3: I expect blockchain platforms for education would be easy to use. | Venkatesh et al. (2003); Kamble et al (2019); Chang et al. (2022) |
| EPR | EPR1: The adoption of blockchain technology in my institution would require support from our educational partners.<br>EPR2: The major educational partners are technologically and financially ready to implement blockchain.<br>EPR3: The value of blockchain innovation is recognized by the educational partners. | Gutierrez et al. (2015); Malik et al. (2021); Chittipaka et al., (2022); |
| PT | PT1: I believe that blockchain platforms for education are trustworthy.<br>PT2: I believe that blockchain solutions for education are reliable.<br>PT3: Even if not monitored, I would trust blockchain to do the job right. | Wu et al. (2012); Lee et al. (2019); Chang et al. (2022) |
| LBR | LBR1: Leadership would need to ensure the availability of personnel with the right level of expertise to support blockchain adoption.<br>LBR2: Leadership is willing to allocate the monetary resources needed to adopt blockchain-based educational platforms.<br>LBR3: Leadership would need to make sure that the institution has the relevant technological infrastructure to adopt blockchain.<br>LBR4: Leadership perceives blockchain technology as strategically important for the higher education institution. | Kamble et al. (2021); Malik et al. (2021); Wang et al. (2022) |
| BIU | BIU: I predict that my institution will adopt blockchain technology in the near future.<br>BIU2: My institution is in favor of adopting blockchain for education.<br>BIU3: My institution intends to use blockchain-based solutions. | Venkatesh & Davis (1996); Kamble et al. (2019); Queiroz & Fosso Wamba (2019) |
| UB | UB1: I predict that my institution is likely to use blockchain technology for education in the future.<br>UB2: I expect that my institution will use blockchain-based educational platforms on a regular basis in the future.<br>UB3: I predict my institution would prefer to use blockchain-driven educational platforms rather than conventional systems. | Venkatesh & Davis (1996); Queiroz & Fosso Wamba (2019); Kabir et al. (2021) |

## Sample and data collection

This study utilized a cross-sectional survey involving 175 educational leaders from higher education institutions in 8 European countries: Austria, France, Germany, Italy, the Netherlands, Romania, Spain, and Switzerland. The participants were specifically selected based on their understanding of the complexities associated with digitalization in the education sector and their awareness of innovative technologies, including blockchain.

The survey was created using Qualtrics and administered from March to May 2023. After filtering out incomplete responses, a total of 175 valid surveys were collected. The highest number of respondents came from Romania (19%), followed by Switzerland (16%) and Austria (14%). The demographic details of the respondents can be retrieved in Table 3.

**Table 3**

*Demographic Details of the Surveyed Participants*

| Countries | No. respondents | Percentage |
|---|---|---|
| Austria | 25 | 14% |
| France | 15 | 9% |
| Germany | 21 | 12% |
| Italy | 23 | 13% |
| The Netherlands | 12 | 7% |
| Romania | 34 | 19% |
| Spain | 17 | 10% |
| Switzerland | 28 | 16% |

A comprehensive collinearity test was also conducted to evaluate whether common method bias (CMB) might affect the data collected through online surveys and artificially impact the relationship between external and internal factors within a single participant (Mentzer & Lambert, 2015). Geisser (1975) introduced a practical method using variance inflation factors (VIF) to detect potential CMB. As presented in Table 4, our findings indicate that all the inner model VIFs derived from the full collinearity test are below 3.3, confirming the absence of common method bias in the model.

**Table 4**

*Inner Model – Collinearity Statistics*

| | VIF |
|---|---|
| BIU -> UB | 1.79 |
| BREL -> UB | 1.79 |
| EE -> BIU | 1.26 |
| EPR -> BIU | 2.52 |
| PE -> BIU | 1.87 |
| PT -> BIU | 2.41 |

## *Analytical Approach*

The validation of the proposed conceptual model was conducted using the PLS-SEM (Partial Least Squares Structural Equation Modeling) approach. Survey data were analyzed using SmartPLS 4.0 software, while PLS-SEM analysis was used to assess the model and test the hypotheses. SEM (Structural Equation Modeling) provides a confirmatory approach, offering more dependable insights into multiple indicator variables' patterns compared to linear regression, which may be limited in accounting for measurement errors. PLS-SEM was selected for this study due to its capacity to estimate causality models with theoretical foundations, making it a modern multivariate analytical method. Furthermore, PLS-SEM excels in determining the connection variance between dependent and independent variables, surpassing covariance-based structural equation modeling techniques (Hair et al., 2017). The analysis involved two steps: examining the measurement model for validity and reliability and then conducting hypothesis testing using a bootstrapping procedure.

# Results

## *Measurement Model*

The study assessed the reliability and validity of all constructs using various measures. Regarding the reliability measurements, results showed that all constructs registered a composite reliability (CR) value that exceeds .70, indicating consistent and reliable measurements (Hair et al., 2017). Similarly, Cronbach's alpha and Dijkstra-Henseler's rho measurements surpassed the .70 threshold, confirming satisfactory internal consistency and reliability (Dijkstra & Henseler, 2015). Additionally, the factor loadings for all indicators exceeded the threshold of .60, as proposed by Rahi et al. (2019), ranging from .77 to .93.

The convergent validity of the constructs was evaluated using the average variance extracted (AVE). Results revealed that all constructs achieved significant AVE scores ranging from .66 to .85, indicating that at least 66.1% of the indicator variance could be attributed to the latent construct. This finding suggests a robust level of convergent validity above the .50 threshold, as indicated by Fornell and Larcker (1981).

The study also examined the Variance Inflation Factor (VIF) to detect collinearity between the constructs. The results revealed that all VIF values were below 5.00, indicating the absence of collinearity among the variables (Hair et al., 2017). The values of factor loadings, VIF, Cronbach's alpha, rhoA, CR, and AVE are presented in Table 5.

**Table 5**

*Convergent Validity and Reliability of Constructs and Measuring Items*

| Construct/Item | | Factor loading | VIF | Cronbach's alpha | rho_a | CR | AVE |
|---|---|---|---|---|---|---|---|
| BIU | | | | .85 | .86 | .91 | .78 |
| | BIU1 | .92 | 3.38 | | | | |
| | BIU2 | .90 | 3.05 | | | | |
| | BIU3 | .82 | 1.66 | | | | |
| LBR | | | | .94 | .94 | .95 | .85 |
| | LBR1 | .90 | 3.40 | | | | |
| | LBR2 | .93 | 4.36 | | | | |
| | LBR3 | .92 | 3.91 | | | | |
| | LBR4 | .93 | 4.25 | | | | |
| EE | | | | .88 | .88 | .92 | .81 |
| | EE1 | .90 | 2.74 | | | | |
| | EE2 | .87 | 2.10 | | | | |
| | EE3 | .92 | 3.01 | | | | |
| EPR | | | | .88 | .89 | .93 | .81 |
| | EPR1 | .91 | 2.65 | | | | |
| | EPR2 | .92 | 2.87 | | | | |
| | EPR3 | .88 | 2.36 | | | | |
| PE | | | | .75 | .77 | .85 | .66 |
| | PE1 | .79 | 1.18 | | | | |
| | PE2 | .82 | 2.60 | | | | |
| | PE3 | .81 | 2.53 | | | | |
| PT | | | | .90 | .91 | .94 | .84 |
| | PT1 | .92 | 3.46 | | | | |
| | PT2 | .88 | 2.40 | | | | |
| | PT3 | .93 | 3.63 | | | | |
| UB | | | | .84 | .85 | .90 | .76 |
| | UB1 | .90 | 3.52 | | | | |
| | UB2 | .93 | 4.00 | | | | |
| | UB3 | .77 | 1.49 | | | | |

Discriminant validity pertains to how different a construct is from other constructs present in the structural model. The discriminant validity of the constructs was firstly assessed using the Fornell and Larcker criterion (Fornell & Larcker, 1981), which states that the shared variance between a construct and its measures should be higher than the shared variance between different constructs (Rahi et al., 2019). The results confirmed the discriminant validity of the constructs as the square root of the average variance extracted (AVE) exceeded the corresponding correlation values between constructs. The discriminant validity results based on the Fornell-Larcker criterion, with the square root of the AVE values on the diagonals (bolded) and correlations on the off-diagonals, can be found in Table 6.

**Table 6**

*Discriminant Validity – Fornell-Larcker Criterion*

| | BIU | LBR | EE | EPR | PE | PT | UB |
|---|---|---|---|---|---|---|---|
| BIU | **.88** | | | | | | |
| LBR | .66 | **.92** | | | | | |
| EE | .49 | .37 | **.90** | | | | |
| EPR | .73 | .62 | .35 | **.90** | | | |
| PE | .68 | .63 | .33 | .65 | **.81** | | |
| PT | .73 | .64 | .44 | .72 | .59 | **.91** | |
| UB | .58 | .51 | .54 | .53 | .54 | .56 | **.87** |

The discriminant validity of all latent variables was also assessed with the Heterotrait-monotrait (HTMT) ratio of correlations. The findings showed that the HTMT ratio satisfied the recommended threshold of being less than .90 (Hair et al., 2017; Henseler et al., 2015), confirming the distinct differences between the reflective variables. The discriminant validity of the constructs based on the HTMT ratio criterion is presented in Table 7.

**Table 7**

*Discriminant Validity- Heterotrait-monotrait (HTMT) Ratio Matrix*

| | BIU | LBR | EE | EPR | PE | PT | UB |
|---|---|---|---|---|---|---|---|
| BIU | | | | | | | |
| LBR | .73 | | | | | | |
| EE | .56 | .41 | | | | | |
| EPR | .83 | .67 | .39 | | | | |
| PE | .81 | .70 | .38 | .76 | | | |
| PT | .83 | .70 | .49 | .80 | .67 | | |
| UB | .69 | .57 | .61 | .61 | .69 | .64 | |

## Structural Model

The significance of the path coefficients was evaluated through a standard bootstrapping procedure with 5000 samples. Furthermore, the coefficient of determination ($R^2$) was also utilized to assess the structural model.

The hypotheses were evaluated by conducting a significance test on the path coefficients, where the t-value must exceed 1.64 at a significance level of .05 or 2 at a significance level of 0.01, as suggested by Chin et al. (2003). The results indicated a statistically significant causal relationship between Performance Expectancy (PE) and Behavioral Intention to Use (BIU) at 1% significance level (PE -> BIU, $\beta = .27$, $t = 5.13$, $p < .01$), providing support for hypothesis $H_1$. The expected positive impact of Effort Expectancy (EE) on Behavioral Intention to Use (BIU) in hypothesis $H_2$ was found to be statistically significant as well (EE -> BIU, $\beta = .17$, $t = 3.08$, $p < .01$). Likewise, Educational Partner Readiness (EPR) demonstrated a significant impact on the Behavioral Intention to Use (BIU) blockchain applications in education (EPR -> BIU, $\beta = .28$, $t = 3.99$, $p < .01$), confirming the support for hypothesis $H_3$. Additionally, Perceived Trust (PT) emerged as the most critical construct influencing the Behavioral Intention to Use blockchain-driven educational platforms (PT -> BIU, $\beta = .28$, $t = 4.31$, $p < .01$), further corroborating the validity of hypothesis $H_4$. In addition, Leadership Blockchain Readiness was found to significantly influence the actual Usage Behavior (UB) (LBR -> UB, $\beta = .22$, $t = 2.78$, $p < .01$). Lastly, Behavioral Intention to Use was also found to be a critical determinant for the Usage Behavior (UB) (BIU -> UB, $\beta = .44$, $t = 5.09$, $p < .01$). These results are consistent with hypothesis $H_5$ and $H_6$, thus supporting their validity. Figure 2 illustrates the causal relationships within the proposed structural equation model. Table 8 presents the significant test results of the path coefficients, including the final determination of whether to accept or reject the hypothesis.

**Figure 2**

*Causal Relationships in the Structural Equation Model*

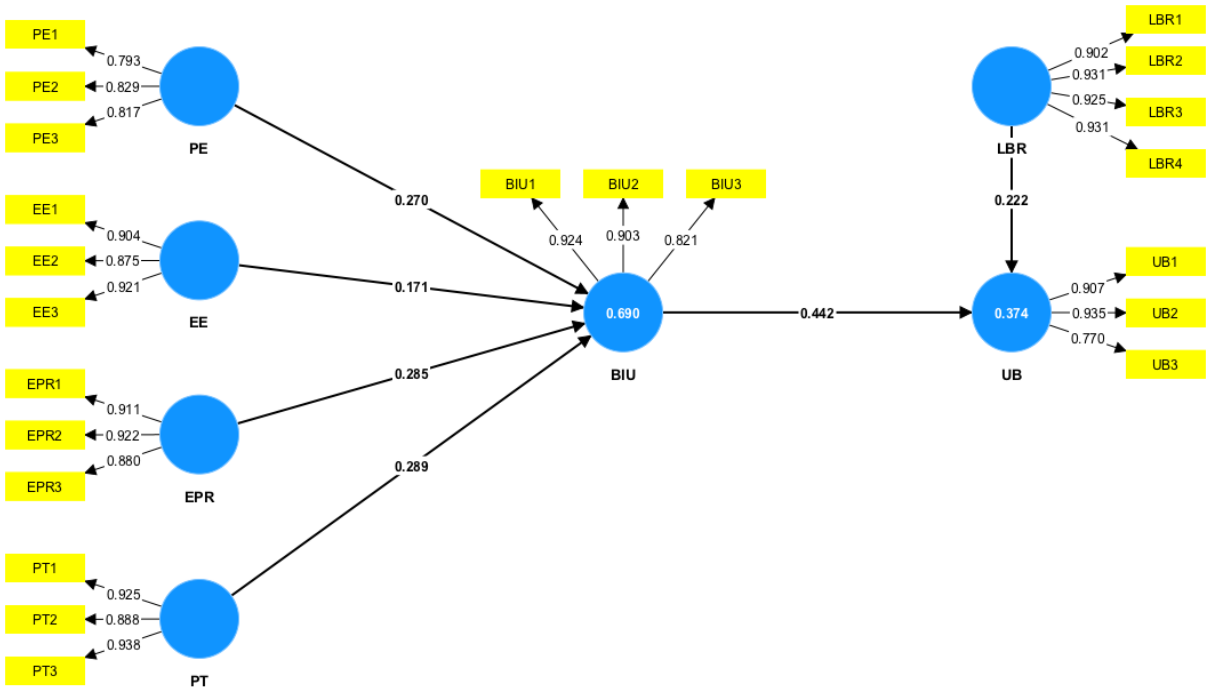



**Table 8**

*Hypothesis Testing*

| Hypothesis | β | *SD* | *t* | *p* | Decision |
|---|---|---|---|---|---|
| H1: PE -> BIU | .27 | .05 | 5.13 | .000 | Supported |
| H2: EE -> BIU | .17 | .05 | 3.08 | .002 | Supported |
| H3: EPR -> BIU | .28 | .07 | 3.99 | .000 | Supported |
| H4: PT -> BIU | .28 | .06 | 4.31 | .000 | Supported |
| H5: LBR -> UB | .22 | .08 | 2.78 | .005 | Supported |
| H6: BIU -> UB | .44 | .08 | 5.09 | .000 | Supported |

The predictive value of the structural model was also assessed through the coefficient of determination ($R^2$). The results indicate that PE, EE, EPR, and PT collectively account for 69% of the variance in the Behavioral Intention to Use (BIU) blockchain-based platforms in the education sector. Additionally, Behavioral Intention to Use (BIU) and Leadership Blockchain Readiness (LBR) account for 37.4% of the variance in Usage Behavior (UB).

## Discussion

This research has investigated and analyzed the key factors influencing the intention to use and actual usage of blockchain-based educational platforms to enable the establishment of a tamper-resistant system that enhances data security, improves operational efficiency, and fosters trust among participants. The findings provide a strong basis for promoting the adoption of blockchain technology in the educational sector.

Survey data collected from 175 respondents in eight European countries revealed variations between the intention to use blockchain platforms and actual usage behavior. The extended UTAUT model, incorporating Educational Partner Readiness (EPR), Perceived Trust (PT), and Leadership Blockchain Readiness (LBR), proved to be both theoretically and statistically valid for blockchain solutions in education. The results of the PLS-SEM analysis showed that model

exhibited a moderately high explanatory power, with Effort Expectancy (EE), Performance Expectancy (PE), Perceived Trust (PT), and Educational Partner Readiness (EPR) explaining 69% of the variation in Behavioral Intention to Use (BIU).

The study results show that Perceived Trust (PT) was the most significant construct influencing the Behavioral Intention to Use (BIU) blockchain-based educational solutions. This finding underlines the pivotal role trust plays in the adoption of blockchain-based platforms in education. Trust is a key factor in embracing novel technologies like blockchain, as it instills confidence and reduces uncertainty for users. In the educational context, blockchain records the behavior of the academic staff and students, leading to a shift in reliance on third-party institutions to trust the technology itself. This finding is consistent with the research of Khazaei (2020), who posited that trust in blockchain technology is a prerequisite before contemplating the adoption of this technology. Additionally, studies conducted by Abu Afifa et al. (2022) and Jena (2022) have demonstrated that trust strongly influences individuals' intention to adopt blockchain technology.

The study results also provide evidence for the significant relationship between Educational Partner Readiness (EPR) and Behavioral Intention to Use (BIU) blockchain-based educational platforms. This finding aligns with earlier empirical studies (AL-Ashmori et al., 2022; Kamble et al., 2021; Malik et al., 2020), emphasizing the significance of partner readiness and effective collaboration among partners in successfully implementing blockchain solutions.

Additionally, the influence of Performance Expectancy (PE) on Behavioral Intention to Use (BIU) blockchain-based educational platforms was found to be significant as well. This result aligns with prior research conducted by Fosso Wamba and Queiroz (2019) and Abu Afifa (2022), whereby the beliefs of individuals regarding the potential enhancement in their performance as a result of a technology implementation had a significant impact on their usage intention. Similarly, the research affirms the substantial influence of Effort Expectancy (EE), which assesses the ease of using blockchain technology based on the time and effort required from users on their Behavioral Intention to Use (BIU) blockchain-based platforms. This result is in line with previous findings (Fosso Wamba and Queiroz, 2019; Pieters et al., 2022).

Lastly, the study reveals that Leadership Blockchain Readiness (LBR) has a significant impact on actual Usage Behavior (UB), supporting earlier research conducted by Toufaily et al. (2021), Chavalala et al. (2022), and Rejeb et al. (2022). This finding suggests that higher education institutions displaying strong leadership readiness, with a managerial commitment to provide technical infrastructure, qualified personnel, access to service providers, and financial resources, are more likely to achieve successful adoption and integration of blockchain solutions in education.

## Theoretical Implications

This research provides valuable and timely contributions to the emerging field of the adoption of blockchain technology in education, bridging the gap in theoretical and empirical research. While previous studies have explored the concept of blockchain technology in education, there is a lack of research focusing on the adoption of blockchain-based educational platforms in Europe. This research explores the determinants of the intention to adopt blockchain-based applications for educational purposes and subsequently investigates the actual usage behavior. By putting forth an extended UTAUT model and gathering empirical data from educational

leaders in eight European countries, the study offers meaningful insights for researchers, practitioners, and policymakers alike.

In terms of theoretical contributions, this study is the first of its kind to enhance the theoretical framework of the original UTAUT model by introducing three novel variables: Educational Partner Readiness, Perceived Trust, and Leadership Blockchain Readiness. Additionally, it represents the first empirical investigation focused on the role of leadership in the adoption of blockchain-based educational platforms in Europe. By employing the PLS-SEM analytical approach, this comprehensive analysis contributes to a deeper understanding of the key determinants of behavioral intention and usage behavior related to blockchain-based educational platforms.

The research results demonstrate that Performance Expectancy, Effort Expectancy, Educational Partner Readiness, and Perceived Trust significantly influence the Behavioral Intention to Use blockchain-based educational solutions. Particularly, Perceived Trust emerges as the most influential factor affecting the usage intention. Regarding actual Usage Behavior, Leadership Blockchain Readiness plays a vital role, encompassing the commitment of leadership to ensure the availability of skilled personnel, monetary resources, and necessary technological infrastructure. Additionally, leaders must perceive blockchain technology as strategically important for their educational institutions.

## Practical Implications

The current research makes valuable practical contributions and provides guidance to educational leaders from higher education institutions in Europe who are seeking to harness the potential of blockchain-based platforms. By shedding light on the factors influencing the adoption of blockchain technology, this study provides educational leaders with a deeper understanding of how to integrate blockchain innovation into the educational process. Furthermore, valuable insights into the determinants of usage intention and actual usage of blockchain-driven platforms would enable educational institutions to align with the shift towards digital transformation. This study aims to equip educational leaders with the relevant tools to make informed decisions, deploy effective strategies, and successfully navigate the intricacies associated with the adoption and usage of blockchain-based platforms.

The findings highlight the significance of Perceived Trust as the primary variable driving the Behavioral Intention to Use blockchain-based educational platforms. As a result, educational leaders must prioritize implementing measures to improve the understanding of the functionality of blockchain-based platforms and their associated benefits in the educational realm. In this context, ensuring the integrity and reliability of academic records and digital credentials holds great significance. Additionally, implementing these measures will aid in building trust among academic staff, students, and educational partners. Furthermore, educational institutions can enhance security and trustworthiness for all stakeholders involved in the educational process by implementing additional measures, such as robust data protection frameworks and transparent governance structures.

The second most influential factor in this study was Educational Partner Readiness, indicating the necessity for educational leaders to put great emphasis on establishing cooperative partnerships with experts and research institutions. This collaborative effort aims to cultivate digital skills that ease the adoption of blockchain technology. By acknowledging

the essential contributions of these partners, educational leaders can enhance their strategic planning and resource allocation while fostering an innovative culture that promotes experimentation.

Two additional variables that exerted a notable impact on the Behavioral Intention to Use blockchain-based educational platforms are Performance Expectancy and Effort Expectancy. Consequently, it becomes imperative for higher education institutions to develop a deep understanding of the benefits of integrating blockchain technology into the educational process. These benefits include automation, streamlined academic record management, cost efficiency, transparency, simplified credential verification, and improved data security. Moreover, it is essential for educational leaders to prioritize the user-friendliness of blockchain-driven educational platforms. By acknowledging and effectively conveying the advantages offered by these platforms, educational leaders can not only promote the adoption and usage of blockchain technology but also empower academic staff and students to explore the transformative potential of this disruptive technology.

Furthermore, the Leadership Blockchain Readiness in adopting blockchain technology significantly impacts the actual Usage Behavior of educational platforms. Therefore, successful implementation necessitates strong leadership support to drive organizational change and foster an innovative mindset. Effective leadership is critical for making informed decisions while also securing essential technical and human resources. Also, educational leaders must be ready to offer relevant guidance for the successful integration of blockchain solutions, ensuring full adoption and utilization within their institutions.

The insights provided by this research hold value for educational leaders as they develop strategies to promote innovation in the education sector. Through the adoption of blockchain technology, educational leaders in Europe can tap into the potential of digital transformation, benefiting their institutions, academic staff, students, and educational partners alike.

## *Limitations and Avenues for Future Research*

Apart from the theoretical contributions and managerial implications identified, it is essential to acknowledge the limitations of this study, as they present opportunities for future research directions. First, whilst the study offers new insights into the variables influencing the intention to use blockchain-based platforms, the empirical testing of the newly developed UTAUT model was based on a limited sample of 175 educational leaders. Also, the study was conducted in a cross-sectional manner, examining the behavior of educational leaders at a single point in time. By providing fresh insights into the integration of variables driving the intention to use blockchain-based platforms, this study creates opportunities for further investigation and application of the model in diverse contexts, enabling a deeper understanding of the decision-making processes behind the adoption of blockchain technology. Consequently, extending the examination of the conceptual model to additional countries and regions would enhance the generalizability of the proposed model. Given the dynamic and evolving nature of blockchain technology adoption, researchers may also consider employing a longitudinal study.

Additionally, it is important to recognize that the proposed factors in the extended UTAUT model are not exhaustive. Various organizational, economic, technical, regulatory, market-related, and social factors create a complex array of considerations for educational institutions

when adopting a new disruptive technology. Hence, researchers are encouraged to explore the integration of additional factors to enhance the explanatory power of the model.

## Conclusions

In the current fast-paced and ever-evolving world, innovation is a key driver of progress in the education sector. While some educational institutions have embraced digital technologies, others face obstacles due to reliance on outdated structures, administrative processes, and non-transparent data systems. Amidst these challenges, emerging technologies like blockchain are gaining recognition for their potential to reshape the educational landscape, offering a tamper-resistant and decentralized system for managing and validating educational records and credentials. However, the successful adoption of blockchain technology in education requires visionary leadership capable of navigating the complexities of blockchain innovation.

Despite the myriad advantages that blockchain technology presents, its implementation in the education sector has not reached significant levels of adoption. Therefore, the main goal of this research was to elucidate the transformative potential of blockchain technology in shaping the future of education while concurrently discerning the determinants impacting the behavioral intention to adopt and utilize blockchain-based educational platforms. Furthermore, this study highlights the significant role of educational leadership in promoting blockchain innovation, focusing on essential competencies and actions necessary for the successful integration of blockchain technology in educational contexts. Educational leaders during the era of digital transformation must efficiently mobilize human resources, embrace change, and prioritize innovation to leverage the advantages of disruptive technologies. They should actively act as agents of change while also serving as professional coaches and mentors, fostering the growth and advancement of their educational communities.

This study employed a quantitative methodology to introduce and validate an extended Unified Theory of Acceptance and Use of Technology (UTAUT) framework. In contrast to the original UTAUT model and previous research on blockchain technology adoption, this study presents an innovative integrated model that introduces three new variables: Educational Partner Readiness, Perceived Trust, and Leadership Blockchain Readiness. The originality of this study lies in the creation of an extended conceptual model, offering valuable insights into the process of adopting blockchain technology within European educational institutions.

Data were gathered through an online survey method from 175 educational leaders across eight European countries. The collected responses were subsequently analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), facilitated by SmartPLS 4.0 software. The findings of this study underscore the impact of Performance Expectancy, Effort Expectancy, Educational Partner Readiness, and Perceived Trust on the Behavioral Intention to Use blockchain-based educational platforms. Moreover, the study establishes Perceived Trust as a crucial determinant influencing the Behavioral Intention to Use blockchain in education. The research results provide significant contributions to the current knowledge base concerning blockchain adoption in the field of education. These insights hold considerable implications for diverse stakeholders, particularly educational leaders, and partners, including policymakers, blockchain technology practitioners, employers, and researchers.

In conclusion, the adoption of blockchain-based educational platforms offers a promising avenue for catalyzing a positive transformation within the European educational ecosystem. By

embracing this technology, educational institutions can unlock opportunities to improve security, reduce costs, enhance trust and transparency, and streamline data management as part of their digital transformation journey. Moreover, blockchain adoption has the potential to enhance trust and transparency throughout the educational process. Nonetheless, it is imperative to acknowledge that successful blockchain implementation requires significant investments in infrastructure and human capital, with educational leaders playing a crucial role in driving and facilitating these endeavors.

## Declarations

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