Distributed ledger system in Higher Education: An extension of Technology Adoption Model.

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***Abstract**:*

With a variety of student and institution focused applications, blockchain technology has the potential to upend existing business processes in higher education. This study aims to investigate educated people's attitudes and actions toward using blockchain technology in higher education. The research recommends expanding the Technology Adoption Model (TAM) to include additional factors like perceived privacy, security, and trust. For the study, a scale that has been verified in the literature has been used. Variance-based partial least square structural equation modeling was used to analyze the proposed link in the model, which was based on a survey of 208 respondents. The study's conclusion showed that the model's features have strongly impactable intentions to use blockchain in higher education. Blockchain technology's perception, usefulness, and trustworthiness are all strongly influenced by perceptions of security and privacy. Respondents to the study say that the use of blockchain in higher education makes the study more secure.

***Keywords** – Blockchain, Higher education, Technology Adoption Model, Security and Privacy, Trust, Effort expectancy*

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INTRODUCTION

Blockchain technology, also known as distributed ledger systems, has the potential to revolutionize higher education by offering a decentralized, secure, and open platform for handling student records, research data, and administrative tasks. Creating digital credentials that can be safely kept and transferred using the technology is one of the main uses of distributed ledger systems in higher education. Employers, other educational institutions, and credentialing organizations can readily verify digital credentials such as diplomas, transcripts, and certificates that higher education institutions can issue on a distributed ledger system. This makes the process of confirming academic credentials more streamlined and effective by doing away with the need for tangible certificates, which are easily lost, falsified, or damaged. Identity verification is another way that distributed ledger systems are used in higher education. Students can safely access educational resources, take part in online courses, and take tests with the use of a distinct and unchangeable digital identity. This can make it unnecessary to present actual identification credentials and offer a safer, quicker way to confirm students' identities.

Using distributed ledger technology, administrative tasks including student registration, course enrolment, and financial assistance disbursement can be made more efficient. Distributed ledger technology enables organizations to offer a safe and open platform for managing student data, facilitating better communication and teamwork across various departments within the organization. Distributed ledger systems can be used to manage and track research data and intellectual property in addition to performing administrative tasks. Institutions may make sure that research data is securely managed and kept, and that ownership and attribution of intellectual property are acknowledged and correctly documented by implementing a distributed ledger system.

While implementing distributed ledger systems in higher education has many potential advantages, there are also several difficulties and factors that should be taken into account. Ensuring privacy and data protection is one of the main issues because student data and academic records are extremely sensitive and call for stringent security measures.

The development of technology and the rise in use of electronic devices is growing worldwide. The globe has altered people's life totally. The entire market landscape has evolved around technology and the economy has also been greatly impacted. Many technological applications have emerged often, but few have lasted due to theirpotential for growth. Blockchain has become a technology for the future through time. The supply chain is only one of the many industries where blockchain technology can be applied, including financial services, manufacturing, food, agriculture, pharmaceuticals, hotels, airlines, and healthcare. Traceability is also promoted via blockchain. (Babich, 2018).Higher education institutions can benefit from the dynamic nature of blockchain in terms of certification, record authentication, hiring, upkeep, and record accessibility. Moreover, it provides a platform for solving several present problems in higher education, such as fraud, security, and trust (Rooksby, 2019). Since blockchain technology is still in its early stages of adoption, a methodical evaluation of current arguments for technological innovation, as well as its potential and effectiveness, is likely to be helpful to both academics and business professionals.Blockchain gives the education sector the infrastructure it needs to support and create its own learning routes. Studies are emphasizing the methods that will revolutionize the educational sector, but there is little research that demonstrates the importance of people's intentions to adopt blockchain technology.Individual responses to such cutting-edge technologies must be carefully monitored to such cutting-edge technologies must be carefully monitored to assess its scalability. The lack of research papers that specifically address individual adoption intention serves as a solid groundwork for this study. This study makes an effort to analyze educated individual adoption behavior towards blockchain technology using the Technology Adoption Model to fill the knowledge gap in the literature (TAM). Technology adoption refers to how individuals, organizations, and societies embrace and integrate new technological innovations into their daily lives or operations. It involves the acceptance, usage, and assimilation of new technologies, ranging from simple tools to complex digital systems. The adoption of technology can have a profound impact on various aspects of society, including communication , commerce , education , healthcare, and entertainment. It enable advancements in. productivity, efficiency, convenience and connectivity, ultimately shaping how we live, work and interact with the world.

This paper is divided into six sections. Section 1 contains the study's introduction. The application of blockchain in higher education is discussed in section two. The conceptual framework created in section three. The fourth section provides a description of the study's methodology and survey instrument. Section five of the study covers data analysis and empirical findings, and part six of the study concludes with recommendations for further research.

BLOCKCHAIN AND HIGHER EDUCATION

Blockchain has developed into a disruptive technology that has the power to change current business procedures. In terms of integrating itself with other industries, such as healthcare, logistics, banking, energy, manufacturing, retail, and life science, blockchain is making steady progress. The use of blockchain has not been left unnoticed in the sector of higher education. It has been noted that the validity of documents, transparency, immutability, and trust provided by blockchain have the potential to revolutionize higher education (Grech,, 2017) Table 1 lists some of the potential blockchain applications for higher education that have been gleaned from the literature.

Table 1. Blockchain Application

Sr. No.	Blockchain implication	Framework
1	Transcripts &record	Protection against counterfeiting, secure certificate access, and management through the bitcoin chain [Gräther, W., Kolvenbach, S.,2018]The blockchain-based method to store academic records and issue degrees automatically after courses are completed [Palma, L.M., Vigil, M.A., Pereira, F.L., Martina, J.E, 2019]Blockchain-based digital certificates are used to prevent the issue of fake certificates. [Cheng, J.C., Lee, N.Y., Chi, C., Chen, Y.H., 2018]Blockchain is a safe, fast, and cost-efficient way to structure record and data [Hameed, B., et al., 2019]
2	Transaction	Using blockchain to bring high data transparency and prevent fraud [Mauri, R.:, 2017]Assessment of learning outcomes based on blockchain [Duan, B., Zhong, Y., Liu, D.2017] Using blockchain can help with sustainability and transparency. [Thomason, J., et al.:, 2018]
3	Libraries	Making a time-stamped, verifiable version of a journal article using blockchain [Irving, G., Holden, J., 2016]Blockchain to give each user a distinct identity and make it easier to transmit digital documents [Griffey, J.2016]
4	Human reso urce	Student progress can be streamlined to suit the employer's needs. [Thayer, T.L.,2018]Internationalization of Higher Education Institutions Using Blockchain [Kamišali´c, A., Turkanovi´c, M., Mrdovi´c, S., Heri˘cko, M., 2019]To prevent data leaking, encrypt data using a blockchain and restrict access to authorized individuals. [Mori, K., Miwa, H., 2019]
5	Digital badg es	Using blockchain technology to provide badges after achieving specified academic milestones [Mikroyannidis, A., Domingue, J., Bachler, M., Quick, K., 2018]System for digital badges that supports blockchain [Choi, M., Kiran, S.R., Oh, S.C., Kwon,2019]Learners have a badge and achievement visualization tool called a passport that they can use to show potential employers their skills. [Mikroyannidis, A., Domingue, J., Bachler, M., Quick, K., 2018]

CONCEPTUAL FRAMEWORK

The study's focus is on examining customer adoption intentions for blockchain in higher education. To measure the same, the Technology Adoption Model (TAM) has been used in the study setting. The Theory of Reasoned Action (TRA), which states that "people's behavior is specified by their intention to carry out their behavior" [Davis, F.D., Bagozzi, R.P., Warshaw, P.R., 1989, Azjen, I., 1980], is the source of TAM. In TAM, Davis introduced perceived usefulness and perceived simplicity. Perceived usefulness was defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" [Davis, F.D., 1989]. Also, it was stated that a person's decision to use new technology depends on how much they think it will increase their productivity at work [Davis, F.D., 1989] The degree to which a person thinks using new technology is effortless was described as perceived ease of use [Davis, F.D., 1989]. Easy-to-use technologies make people feel less threatened by them and help them create a positive attitude towards using them [Davis, F.D., 1989, Moon, J.W., Kim, Y.G., 2001].

"Positive or negative sentiment towards the usage of technology" was used to define the attitude [Davis, F.D., 1989]. Individual attitudes have been shown to be a good predictor of behavior, and the usage of new technology can change people's attitudes towards using it, which could then influence an entire system [Rice, R.E., Aydin, C.:, 1991]. TAM has been indicated to be an effective model for predicting intentions to embrace new technologies, but it must also be adjusted for environmental circumstances [Mezhuyev, V., Al-Emran, M., Fatehah, M., Hong, N.C.,2018]. In keeping with the same, TAM was increased through trust, perceived security , and privacy. Studies have extensively covered the significance of security and privacy and shown that it acts as a barrier to the adoption of new technology [Aladwani, A.M., 2001]. The threat of security was seen as impeding the adopt of new technology. Perceived security and privacy describe how someone thinks that access to, use of, and exposure of personal information will be kept private [Amin, H., Ramayah, T., 2010]. As a result, people start to believe and trust the system, and earlier research has shown that perceived security and privacy have a large beneficial impact on trust [Roca, J.C., García, J.J., De La Vega, J.J., 2009]. Moreover, trust was proven to be a powerful predictor of individual attitude [Wu, L., Chen, J.L., 2005]. When it comes to adopting and using technology, factors such as effort expectancy, attitude, security, and privacy can greatly influence an individual's behavior. Effort expectancy refers to how easy it is to use technology and the effort required to do so. A positive attitude towards technology can increase perceived effort expectancy, leading to a greater likelihood of adoption and use. On the other hand, concerns over security and privacy can negatively affect both attitude and effort expectancy toward technology adoption and use. This means that technology developers and providers should prioritize addressing these concerns by offering secure and privacy-focused technologies in order to promote adoption and use

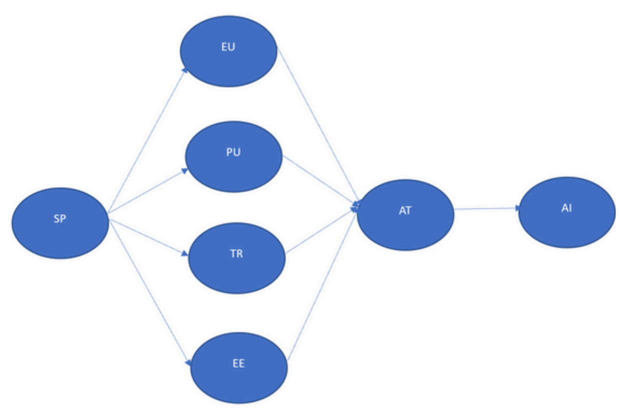

Figure 1. Conceptual framework

Note: SP: Security and Privacy, EU: Ese of use, PU: Perceived usefulness, TR: Trust, EE: Effort expectancy, AT: Attitude, AI: Adoption intention

H1: EU significantly influences each person's attitude towards using blockchain technology in higher education.

H2: Individual AT towards the use of blockchain technology in higher education is significantly positively impacted by PU of use.

H3: AT has a significant positive influence on AI towards blockchain technology in higher education.

H4: TR significantly influences each person's attitude about implementing blockchain technology in higher education.

H5: SP greatly enhances EU's adoption of blockchain technology in higher education.

H6: SP significantly improves PU for higher education's use of blockchain technology.H7: SP significantly influences TR in a favourable manner.
H8: SP significantly influences EE in a favourable manner.
H9: EE significantly influences AT

METHODOLOGY

For the study, scale that has been use validated by the literature has been used. To expand the current TAM model in the context of the study, the latent components perceived ease of use (EU), perceived usefulness (PU), attitude (AT), and adoption intention (AI) towards blockchain have been used in addition to the existing constructs. The responses to the attitude scale items were recorded using a seven-point Likert scale that ranged from 1 for strongly agreeing to 7 for strongly disagreeing, with 1 being the worst possible attitude and 7 being the best possible attitude. Table 2 provides descriptions of latent constructs in more depth. As a survey tool, a questionnaire was created with respondents in the 18 and older age range in mind.Due to the technical nature of the research project, both professionals and students were targeted. The knowledgeable person can simplify and improve your understanding of the technical facts (Chan, R.Y.:, 2001). There were 24 statements in the questionnaire that was given out in the Delhi-National Capital Area of India. The respondents received assurances that their answers would be used for scholarly investigation. The sample was chosen at random from the population using convenience sampling. To contact respondents, the study tool was disseminated via several social media channels. A total of 410 questionnaires were distributed, and 208 of them representing a response rate of 51% were fully completed. According to the demographic breakdown of respondents shown in Table 3, out of the total respondents 86 were female and 122 (58.65%) were men. Graduates (37%) and other respondents (43%) made up the majority of the respondents. Data analysis also reveals that 45% of respondents were professionals, such as academicians at various degrees and IT personnel, while 55% of respondents were students. A thorough collinearity test was used to address the typical way of bias, and the VIF for every latent construct was shown to be less than 5. [Kock, N., Lynn, G., 2012]

RESULT AND DISCUSSION

With the aid of Smart-PLS. 2.0 and SPSS 21.0, data analysis was carried out. SPSS 21.0 was used to determine the data's descriptive nature. For structural equation modelling, Smart-PLS 2.0 was used in two steps: measurement model assessment and structural model assessment [Anderson, J.C., Gerbing, D.W., 1988].

A structural equation modelling (SEM) method called smart PLS (Partial Least Squares) enables researchers to examine intricate correlations between variables. The measurement model in Smart PLS is used to evaluate the reliability and validity of the measurement tools or scales used in the research. It is the initial stage in the analysis. The reflecting and formative indicators make up the two key components of the measurement model. Reflective indicators are those that gauge a latent variable or construct, such as patronage of a certain brand. It is considered that these indicators can be used interchangeably, making them interchangeable measures of the same construct. As a result, they need to have a strong correlation with one another and contribute to the construct's overall reliability.

The measuring model is evaluated for its validity and reliability using a variety of statistical tests after the indicators have been chosen and allocated to reflective or formative categories. These assessments include discriminant validity, average variance extracted (AVE), concept reliability, and factor loading. To guarantee the validity and reliability of the measuring instruments, the measurement model must pass specific requirements.

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Overall, the Smart PLS measurement model is an important stage in the SEM analysis because it ensures the accuracy and precision of the measuring tools and establishes the correlations between the variables under study.

The structural model comes after the measurement model in Smart PLS (Partial Least Squares) analysis. It is used to examine correlations or test hypotheses involving latent variables or constructs. The structural model is used to determine the importance and strength of the interactions between the constructs as well as to pinpoint the key variables that have the greatest impact on the outcome variable. Path coefficients and their significance levels are calculated as part of the structural model analysis. The intensity and direction of the links between the constructs are represented by the route coefficients. They are computed using the formative indicators' path coefficients and the reflecting indicators' outer weights. By resampling the data and estimating the path coefficients numerous times, bootstrapping analyses the importance of the path coefficients. This aids in calculating the path coefficients' confidence

MEASUREMENT OF MODEL ASSESMENT

The reliability and validity of each item should be measured before examining the structural relationship among constructs. Internal consistency among items was measured through composite reliability (CR). As represented in Table 4, the identified CR value for AI, AT, PU, SP, PU, and TR was found to be above 0.7 and considered reliable [Nunnally, J.C., 1981]. The AVE for all latent constructs AI, AT, PU, SP, PU, and TR was well above the defined threshold of 0.5 and √AVE represented in the diagonal exceeds the off-diagonal values in the correlation matrix provides evidence for convergent and discriminant validity [Fornell, C., Larcker, D.F., 1981, Chiu, C.M., Wang, 2008]. As represented in Fig. 2 all item loadings were more than 0.7 and establish indicator reliability [Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E., Tatham, R.L., 1998].

Table 3. Demographic Profile

Variables	Number	Percentage (%)
Gender		
Male	120	57.69%
Female	88	42.30%
Education Qualification		
Graduate	76	36.53%
Postgraduate	90	43.26%
Others	42	20.19%
Occupation		
Student	112	53.84%
Academicians	50	24.03%
Professionals	46	22.11%
TOTAL	**208**	**100%**

Table 4. Reliability and Validity Result

	AI	AT	EU	SP	PU	TR	EE
AI	**0.889**						
AT	**0.515**	**0.829**					
EU	0.479	0.492	**0.729**				
SP	0.479	0.376	0.474	**0.789**			
PU	0.459	0.623	0.494	0.339	**0.749**		
TR	0.531	0.565	0.497	0.584	0.583	**0.828**	
EE	0.432	0.543	0.447	0.541	0.443	0.323	**0.798**
CR	0.923	0.877	0.778	0.838	0.796	0.904	0.769
AVE	0.799	0.714	0.539	0.633	0.566	0.703	0.547

Table 2. Description of latent construct

Construct	Scale	Reference
Attitude (AT)	AT1: Using blockchain technology is extremely bad (1) / extremely good (7); AT2: Using blockchain technology is extremely undesirable (1) / extremely desirable (7); AT3: Using blockchain technology is extremely unenjoyable (1) / extremely enjoyable (7); AT4: Using blockchain technology is extremely unfavorable (1) / extremely favorable (7)	***(Kim, Y., Han, H., 2010)***
Perceived eas e of use(EU)	EU1: I would have no trouble learning a blockchain-based system; EU2: I believe a system based on blockchain would be simple to create; EU3: In a blockchain-based system, skillfulness is simple; EU4: The system based on blockchain is simple to use.	***(Venkatesh, V., Thong, J.Y., Xu, X., 2012)***
Perceived use fulness(PU)	PU1: A system based on blockchains would improve my performance; PU2: My productivity would increase with a blockchain-based system; PU3: My effectiveness would increase with a blockchain-based system; PU4: My processing time would be shortened with a blockchain-based approach.	***(Venkatesh, V., Thong, J.Y. , Xu, X., 2012, Taylor, S., Todd, P.A.:)***
Adoption inte ntion (AI)	AI1: I'm planning to use a system based on blockchain; AI2: A blockchain-based system would I use; AI3: I'd like to utilize a blockchain-based system; I'd make the necessary effort to use a blockchain system, according to AI4.	***(Chow, W.S., Chen, Y., Paul, J., Modi, A., Patel, J., 2016)***
Security and privacy(SP)	PSP1: The system based on blockchains is theoretically secure to use; PSP2: The implementation of the blockchain-based technology is robust; PSP3: The system has my confidence; PSP4: I think the data secrecy system is effective.	***(Pikkarainen, T., Pikkarainen, K., Karjaluoto, H., Pahnila, S., 2004)***
Trust (TR)	TRT1: It is dependable; TRT2: It conveys a sense of promise and dedication; TRT3: It continues to take my interests into account; TRT4: This system is long-lasting.	***(McCloskey, D.W., 2006, Jarvenpaa, S.L., Tractinsky, N., Vitale, M., 2000)***
Effort expectancy (EE)	EE1: Blockchain use is less stressful; EE2: Use does not require more technical expertise. EE3: Blockchain use does not require much expertise. EE4: Its capability is efficient.	***(Jarvenpaa, S.L., Tractinsky, N., Vitale, M., 2000)***

STRUCTURAL MODEL ASSESSMENT

The relationship hypothesis was examined using non-parametric bootstrapping, and the results are shown in Fig. 2. One of the key metrics for assessing the causal relationship in the structural model is a large route coefficient. The study's findings offer adequate empirical backing for the relationship that has been proposed. Individual attitudes regarding blockchain technology are highly influenced by the fundamental TAM variables perceived ease of use and perceived usefulness, which support H1 (β = 0.168, t = 5.325) and H2 (β = 0.337, t = 9.778). In higher education, the attitude was discovered to be a powerful predictor of individual adoption intention for blockchain; H3 (β = 0.505, t=18.269). To broaden and improve the ability to forecast individual adoption intentions for blockchain in the higher education system, trust and perceived security and privacy were now added. Individual attitude is significantly positively influenced by trust; H4 (β = 0.316, t = 11.333). Moreover, trust is significantly positively influenced by perceived privacy and security (H7 β = 0.582, t = 22.839), perceived usability (H5 β = 0.470, t = 13.473), and considered simplicity of use (H6 β = 0.338, t = 8.295). R2 quantifies the amount of variance.

In the dependent variable caused by the independent variable and explains the predictive power of the model. R2 was evaluated using the proposed range of 0.19, 0.33, and 0.67, which, respectively, indicate mild, moderate, and considerable impacts [Chin,W.W., 1998]. The structural model's predictors account for a moderate impact on student intentions to use blockchain technology (R2 = 35.5%) and individual attitudes (R2 = 47.3%). Furthermore, the acceptance of the hypothesis suggests that a significant effect of predictor variables on the outcome variable. The three independent variables EU, PU, and TR, which stand for user aspect and belief, are positively correlated with consumer attitude towards blockchain implementation in higher education. One of the most important behavioral factors influencing behavior is consumer attitude.The three predictors' ability to accurately predict attitude varies. The innovation can create the individual assumption to act aggressively towards blockchain-based solutions by providing high levels of trust and confidence, convenience, and usability (Albayati, H., Kim, S.K., Rho, J.J., 2020).

The inverse link between risk and trust emphasises how a person's perception of risk rises as trust declines. One of the essential components for boosting innovation confidence is trust, which helps people believe how effectively and with less effort they can use the technology. The main element of this model to represent the degree of complexity of blockchain innovation and use is SP.`

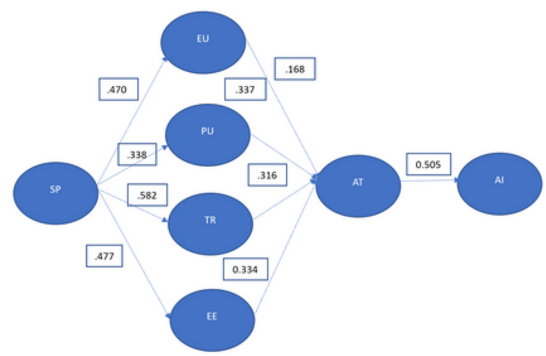

Figure 2: Structural Report

CONCLUSION

The technology adoption model (TAM) has been used in numerous studies to investigate individuals' intentions to embrace new technologies in various ways [Arpaci, I., Yardimci Cetin, Y., Turetken, 2015]. As of Now that it offers a wide range of possibilities for a secure and safe operational environment, blockchain has demonstrated a quick spread across the globe. The technology, however, did not meet expectations, and its actual use is still incredibly low. This article sought to investigate blockchain's adoption intentions in higher education considering the technology's limited application. The proposed expanded model offers a perspective on how blockchain innovation is received considering the rise of innovation. The study's conclusions showed that the model's features have a strong beneficial impact on people's intentions to use blockchain in higher education. Perceptions of security and privacy have become one of the most important variables influencing perceived usefulness of blockchain technology. Respondents to the study say that the use of blockchain in higher education makes them feel safe and assured. Also, the increased security provided by blockchain is crucial for success, prompting the organization to invest in developing a secure environment and trustworthy systems and platforms that protect clients' sensitive information from illegal modification, deletion, or fabrication. With strong managerial backing, the deployment of blockchain in education is feasible. The collaboration between the institutional members may be further improved as a result. Institutions of higher learning should develop policies for the efficient use of cutting-edge technologies. The government should create legislation to encourage and inform individuals about the advantages of implementing blockchain technology in the field of education. As people become more aware of technology and its usefulness through implementation, its use will spread. This study contributes a few important things. In order to explore the attitude-behavior gap while choosing blockchain-based applications in higher education, the study first expands TAM. The study emphasizes the important significance of perceived security, privacy, and trust for blockchain adoption in higher education, despite the fact that TAM has previously been confirmed to understand the behavior of technology adoption in many environmental situations [45]. The study can also be expanded by looking at how personality qualities, social, economic, and cultural aspects, and blockchain adoption are related. Higher education is one of the many sectors that blockchain technology has the potential to revolutionize. Degrees, diplomas, and certifications can be created with tamper-proof academic records using blockchain technology, which is decentralized and secure. Employers may have a more simplified and effective hiring procedure as a result, and the danger of fraud or falsification may also be decreased. The ability to readily and securely exchange one's academic credentials with prospective employers, educational institutions, or other relevant parties is made possible through the use of blockchain technology for credential verification. Additionally, this can result in less administrative work for educational institutions and increase the legitimacy and correctness of the credentialing procedure. In addition, blockchain technology can make it easier to build secure, decentralized learning systems that let users access and exchange knowledge with one another. Increased collaboration and knowledge sharing may result from this, and it may also lower the price of traditional classroom-based education. By enabling more effective and secure academic record-keeping, improving the credentialing process, and supporting alter the landscape of higher education. Furthermore, the Nation Education Policy 2020 emphasizes the importance of leveraging technology in education. It highlights integrating technology to enhance teaching and learning processes, promote personalized learning, facilitate assessments, and improve administrative efficiencies. However, it is worth noting that blockchain technology has gained attention in various sectors due to its potential to enhance transparency, security, and efficiency in record-keeping and data management. In the context of education, blockchain has the potential to address issues such as credential fraud, secure storage and verification of academic records, and enable decentralized learning platforms. Several countries and educational institutions worldwide have started exploring the application of blockchain in education.

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