Securing a Cloud-based E-learning Portal Using Blockchain

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Abstract

E-learning has changed the dynamics and characteristics of education and research. It has completely transformed the way pupils study. Compared to traditional learning methods, the benefits of e-learning include consistency, scalability, and cost savings. However, several technical and security obstacles and flaws with the learning system have been encountered. The proposed blockchain system increases data security and eliminates trust issues between users and third-party entities accessing apps and services. Data distribution may be used with smart contracts to ensure that institutions maintain control over their data entry, are aware of the source of acquired data sources and are kept up to date when their data is updated.
Cloud computing has the potential to be the primary driving force behind e-learning. How this breakthrough technology and security may assist the field of e-learning. This study examines cloud security, such as how it might improve the safety of private keys and network computing services such as servers, databases, and storage. Blockchain takes advantage of Cloud computing features to enhance data security. Furthermore, a detailed discussion of the impact of Cloud Computing on e-learning and the security concerns and features might make the most out of the merger of both disciplines by including blockchain technology.

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1. Introduction

Cloud computing refers to using servers accessed over the Internet to run software applications and store databases, resulting in cost savings and increased flexibility in managing computing resources. Virtualisation makes this possible, which creates virtual machines (VMs) that behave like physical computers with their hardware. These VMs are sandboxed from one another, so files and applications from one VM are not visible to others on the same physical machine.
Cloud-based e-learning platforms provide a scalable and cost-effective solution for hosting and managing learning content, allowing educators and students to access content from anywhere with an internet connection and collaborate in real time. These platforms also offer features like automatic backups, disaster recovery, and scalability to handle increasing numbers of users.
In the future, blockchain technology could increase the security and privacy of e-learning platforms. Blockchain is a distributed ledger that stores tamper-evident data as a chain with no central authority. Nodes actively validate and verify data, and data saved on the blockchain is encrypted and unchangeable, safeguarding data and removing privacy concerns present in traditional centralised systems.

1.1 Background

The electronic learning system organises and saves information from electronic books into categories. Students and other users may use the system to keep track of all the books and videos that are accessible, download them, or view/read them online. Colleges must now maintain an ongoing audit of the books distributed and returned. Additionally, it occurs when students need help to return their books. The loss of the books is then on the college. Thus, allowing students to download e-books from the system, the technology eliminates the requirement for issuing books and manually tracking them. It has books organised by semesters and branches so students can quickly access the e-books and learning materials they want.

On March 11, 2020, the World Health Organisation (WHO) designated COVID-19 as a pandemic illness. To stop the COVID-19 virus from spreading, an emergency status was proclaimed on March 19. There is a two-month curfew that follows it.
Due to this, remote online education is now the primary focus of colleges. Due to university closures, it is now more important than ever to have a solid infrastructure and be prepared to provide online courses. Online education turns to become a tool for social isolation and epidemic control. Online learning offers helpful learning resources and 24/7 access to educational platforms at the student's convenience. It also provides flexibility, independent of location and hour. Additionally, it offers free questions and answers for students as well.

1.2 Related work

E-learning is a means to offer lessons quickly. This modality provides relatively short delivery cycles compared to the conventional classroom teaching approach. This means that compared to traditional learning, learning time is shortened by 60 per cent. Some of the explanations for how eLearning cuts down on learning time include turnitinuk.com
• Lessons begin right away and are completed in a single learning session. This makes it simple to launch training programs within a few weeks or sometimes even just a few days.
• Rather than adopting the group's pace, learners can choose their own learning pace.
• Saves time as students do not have to attend the training site. With the ease of features to expedite transaction execution, you may study at home. The cloud can, in this case, supply on-demand computer resources for blockchain activities due to its flexibility and scalability. Public clouds, for instance, may provide blockchain service providers with a broad network of resources in a federated cloud environment. As a result, cloud computing and blockchain technology integration may expand effectively. arxiv.org

Due to the lack of study, online and virtual learning are often expected developments in e-learning. The use of blockchain technology in education is also a developing research subject. Bring-your-own-device policies have been made easier to adopt in schools thanks to blockchain technology, which has shown to be more effective than previous techniques in safeguarding educational data.

With smart contracts, blockchain technology may detect the sharing of educational resources, maintain academic archives in a trustworthy decentralised system, and encrypt data to secure academic materials. Other advantages of blockchain technology include immutability, dependability, and data integrity. Chen, Q., Xu, C., & Lu, Q. (2018).
Blockchain in education: A review and a case study. Smart Learning Environments, 5(1), 1-14. The research presented here offers an in-depth examination of the existing literature on using blockchain technology in education and a case study on implementing a blockchain-based educational system. By Bhavesh K. Patel, Hiren B. Patel, and Vipul K. Dabhi (2018), "Blockchain-based secure e-learning system" - The authors of this study put forth a secure e-learning system built on a blockchain that makes use of smart contracts to control access to educational materials.

Mohammad A. Alzahrani, Mohammad A. Almeshal, and Abdullah A. Alasaad (2020), "A blockchain-based e-learning platform for securing learner's data and privacy" - The authors of this research suggest a decentralised, blockchain-based e-learning platform that protects the confidentiality and privacy of student data.

Ramanathan Palaniappan and Rajesh Kannan Megalingam's "A Blockchain-based secure E-learning platform using Ethereum" (2020) - The authors suggest creating an Ethereum-based blockchain-based secure e-learning platform offers tamper-proof access to learning content. Sarwar M. Azhar, Sohail Iqbal, and Adnan Abid's "Blockchain-based secure and decentralised e-learning system" (2019) - In this work, the authors suggest an e-learning platform based on safe blockchain, decentralised, and uses smart contracts to control access to educational materials.

These studies give essential insights into the possible uses of blockchain technology in the field of e-learning, as well as demonstrate the viability of utilising blockchain to secure cloud-based e-learning systems.

1.3 Research questions

1. How can blockchain technology enhance the security of cloud-based learning portals?

   Solution: Implement a permit blockchain network that allows for secure and transparent data sharing between users and prevents unauthorised access.

2. What are the potential benefits of using blockchain for securing e-learning portals?

   Solution: Blockchain provides secure data storage and sharing, immutability, and transparency, which can enhance the security and trustworthiness of e-learning platforms.

3. What are the limitations of using blockchain technology for securing e-learning portals?

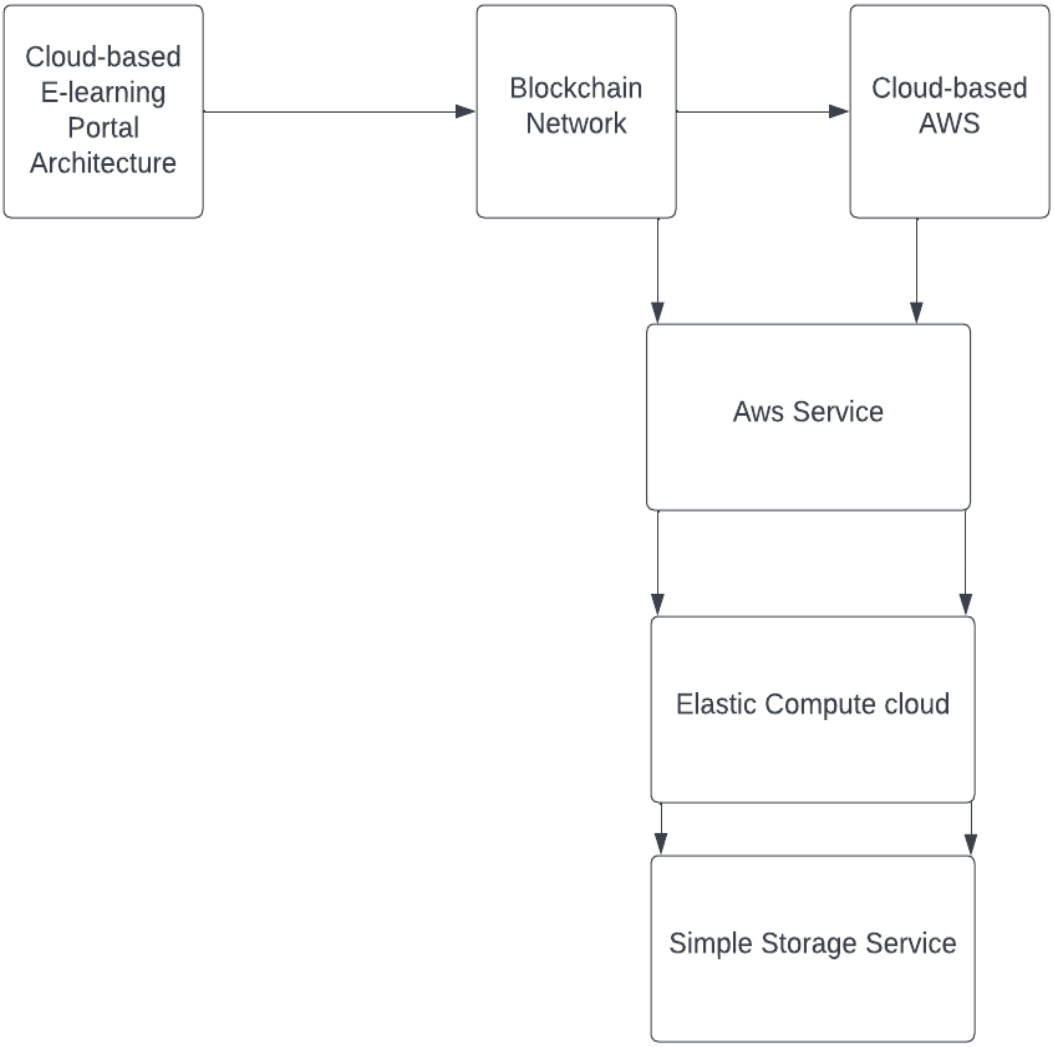
Solution: Some limitations include scalability issues, lack of standardisation, and high energy consumption.

4. How can blockchain technology be integrated into existing e-learning platforms?

Solution: Develop an application programming interface (API) that seamlessly integrates blockchain technology into existing e-learning portals.

5. What security measures can be implemented on the blockchain to ensure the integrity and confidentiality of e-learning data? Solution: Implement encryption, multi-factor authentication, and access controls to protect the data on the blockchain.
6. How can blockchain-based identity management systems authenticate users on e-learning portals? Solution: Use a decentralised identity management system that stores user credentials on the blockchain and allows for secure authentication and authorisation.
7. How can blockchain-based smart contracts be used to automate e-learning processes? Solution: Develop intelligent contracts that automate tasks such as grading, certification, and course completion, which can reduce administrative overhead and enhance efficiency.
8. How can blockchain-based micro-credentialing be used to validate skills learned on e-learning platforms? Solution: Develop a micro-credentialing system that issues digital badges on the blockchain to validate specific skills learned on e-learning platforms.
9. What are the legal and regulatory challenges associated with using blockchain for securing e-learning portals? Solution: Develop a legal and regulatory framework addressing data privacy, liability, and intellectual property rights.
10. How can blockchain-based e-learning portals be made accessible to users with disabilities? Solution: Ensure that the blockchain-based e-learning portals comply with accessibility standards such as the Web Content Accessibility Guidelines (WCAG) to ensure that users with disabilities can access the content.

1.4 Research methodology



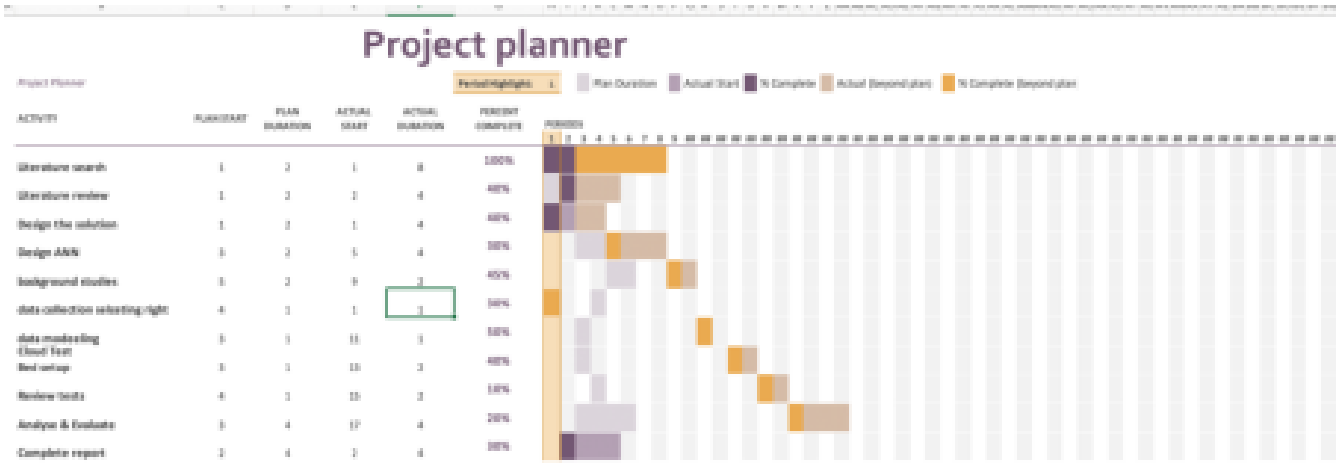
The popularity of cloud-based E-Learning portals has increased significantly due to their convenience and accessibility. However, security remains a critical concern for such platforms, especially regarding the authentication of users and the protection of their sensitive data. Blockchain technology has emerged as a promising solution to these security challenges by providing an immutable and decentralised transaction ledger.

The E-Learning Portal is hosted on the cloud using Amazon Web Services (AWS) services in this architecture. AWS is a well-established provider of cloud computing services, offering a range of computing, storage, and database services that can host and manage cloud-based applications (Amazon Web Services, n.d.). The E-Learning Portal communicates with a

blockchain network that is hosted on an online platform. The blockchain network is responsible for verifying the transactions and storing them in a secure and immutable manner. The use of blockchain technology in E-Learning portals has several advantages. First, it provides a secure and decentralised way to authenticate users, which can help prevent unauthorised access to the platform. Second, blockchain technology can securely store and manage users' sensitive data, such as academic records, without a centralised authority. Third, blockchain technology can provide a transparent and tamper-proof audit trail of all the transactions on the platform, which can help detect and prevent fraud (Hassan et al., 2020). To implement this architecture, the E-Learning Portal must communicate with the blockchain network using a set of APIs. Application Programming Interfaces (APIs) provide a standard way for software applications to communicate with each other and exchange data (IBM, n.d.). The blockchain network would need to be designed to support the specific requirements of the E-Learning Portal, such as user authentication and data storage.
AWS services such as (EC2) and Simple Storage Service (S3) can be used to host and manage the E-Learning Portal. EC2 creates virtual machines that host the portal, while S3 stores the data and files associated with the portal. EC2 and S3 are both highly scalable and can be used to accommodate the growing demands of the E-Learning Portal (Amazon Web Services, n.d.).

Blockchain technology can provide a secure and decentralised way to manage E-Learning portals. By hosting the portal on AWS and communicating with a blockchain network, it is possible to offer a fast and scalable solution for hosting and managing cloud-based E-Learning platforms.

1.5 Research plane



CHAPTER 2: Literature Review

2 Introduction

Blockchain technology has gained significant attention in recent years due to its potential to improve security and transparency in various industries, including education (Dang, 2021). The global blockchain in education is projected to grow at a CAGR of 56.4% from 2020 to 2027, reaching $1.37 billion (Allied Market Research, 2020).

In e-learning, blockchain technology can offer several benefits, including secure and tamper-proof record-keeping, reliable verification of academic credentials, and protection against cyber-attacks (Dang, 2021). However, the integration of blockchain technology in e-learning platforms is still in its early stages, and there is a need for further research to explore its potential applications and limitations (Iqbal & Asif, 2020).

Cloud computing has become increasingly popular in education, providing scalable and cost-effective e-learning solutions (El-Madany et al., 2021). AWS is one of the leading cloud computing platforms, offering various services such as virtual servers, storage, and databases. The combination of blockchain and cloud computing, particularly AWS, has the potential to enhance the security and reliability of e-learning platforms (El-Madany et al., 2021).

2.1 Definition of Blockchain Technology

Blockchain technology is a distributed ledger continuously growing and linked like a chain of blocks. It is characterised by its security, transparency, and immutability, and it is used in various industries, including education. Blockchain technology has received significant attention recently due to its potential to improve security and transparency in various sectors, including education.

Stuart Haber and W. Scott Stometta first proposed the concept of blockchain technology in their article "How to timestamp a digital document" in 1991. They proposed a system that could be used to timestamp documents and ensure that they could not be altered. However, in 2009, the pseudonymous Nakamoto Santoshi created the Bitcoin project based on blockchain technology. Nakamoto (2008) characterised Bitcoin as an electronic payment system that relies on cryptographic mechanisms instead of a central authority to control transactions, allowing two parties to interact directly without needing a third party.

Bitcoin was the first blockchain version that solved various financial difficulties by improving financial services. Later in 2015, Ethereum was created, the second-largest blockchain to be built. Ethereum increased computer code storage and execution, enabling intelligent contracts (Chen et al., 2019). Even though Stuart Haber and W. Scott Stometta (1990) did not use the term blockchain in their work, their concept of implementing a chain of blocks with cryptographic links between them laid the foundation for the development of blockchain technology.

Using blockchain technology in e-learning platforms can provide several benefits, including secure and tamper-proof record-keeping, reliable verification of academic credentials, and protection against cyber-attacks. In addition, cloud computing in the education sector, particularly AWS, can offer scalable and cost-effective e-learning solutions. The combination of blockchain and cloud computing has the potential to enhance the security and reliability of e-learning platforms, providing a more secure and efficient platform for educators and students.

In conclusion, blockchain technology is a promising solution for securing and improving the transparency of e-learning platforms. Integrating blockchain technology and cloud computing, particularly AWS, can enhance the security and reliability of e-learning platforms. Further research is needed to explore this integration's potential applications and limitations in e-learning platforms.

2.2 Blockchain Technology Security

Blockchain technology has become increasingly popular in recent years due to its potential for privacy and security. Security is a critical component of modern life, as technology usage by people and organisations continues to grow astoundingly. Blockchain technology is crucial when data needs to be stored and distributed securely and effectively (Swan, 2015).

Sensitive data exchanged between systems and applications must be safeguarded from various security risks. A single source of truth can be controlled and accepted by all nodes in the network using the blockchain consensus algorithm. Nakamoto (2008) proposed a proof-of-work technique that enables participants to coordinate equally.

Blockchain technology has gained popularity recently due to its potential for anonymity and security. Security is critical in today's society, with more people than ever and networks being organised. Additionally, the way that blockchain operates compels its users to act honorably. In their 2021 article, Hougan and Lawant examined how unprofitable it is to carry out fraudulent transactions on the Bitcoin network. If the miners were willing to invest hundreds of millions of dollars in computing power, they could hack the system if their combined processing power was greater than that of the rest of the network (Hougan & Lawant, 2021).

Although numerous researchers have demonstrated and explained that it is virtually impossible to destroy a blockchain, users are still concerned about its security. Blockchain continues to experience attacks and security flaws. According to Loi et al. (2016), 8,833 out of 19,366 currently active Ethereum contracts are weak, which could result in losses. Since the development of the internet, many other types of technology, including computers and electronic databases, have been used in blockchain systems.

2.3. E-learning

The concept of e-learning has been evolving over the years with the advancement of technology. The development of innovative programs for instruction and communication between teachers and learners has been one of the driving forces behind the growth of e-learning (Nouri & Shahid, 2019). The affordability of computers and internet access has also significantly made e-learning accessible to a broader audience (Liaw, 2008).

In recent years, e-learning has become a popular mode of education delivery, with many institutions adopting it as a primary method of instruction. This shift has been attributed to the flexibility and convenience that e-learning offers, allowing learners to access education from anywhere and at any time (Borup et al., 2014). Additionally, e-learning has been shown to improve learning outcomes and increase student engagement compared to traditional classroom-based instruction (Bernard et al., 2014).

However, some challenges are associated with e-learning, such as the need for learners to be self-motivated and disciplined, the potential for social isolation, and the digital divide that can limit access to technology and internet connectivity (Mtebe & Raphael, 2020). Despite these challenges, the growth of e-learning is expected to continue in the coming years, driven by advancements in technology and the need for flexible and accessible education delivery methods (Kumar & Sharma, 2021).

2.4 Cloud Computing

Cloud computing refers to delivering computing services, including servers, storage, databases, software, and analytics, over the Internet. E-learning portals can benefit from cloud computing in various ways, including cost savings, scalability, flexibility, and improved collaboration.

Cloud computing allows e-learning portals to avoid the costs of maintaining on-premises hardware and software, such as server maintenance and updates. Instead, e-learning portals can rent computing resources from cloud service providers, paying only for what they use (Alzahrani et al., 2019). This makes cloud computing an attractive option for e-learning portals, particularly those with limited budgets.

Moreover, cloud computing allows e-learning portals to scale their resources up or down based on their needs. This means that e-learning portals can easily accommodate changes in the

number of users, courses, and content without investing in additional hardware or software (Bhatti & Ahmad, 2021). This makes cloud computing a flexible solution for e-learning portals, particularly those with rapidly changing requirements.

Another benefit of cloud computing is improved collaboration. Cloud-based e-learning portals allow students and instructors to access course content and communicate with one another from anywhere, anytime, and on any device. This improves access to education, particularly for students who live in remote or underserved areas (Bautista et al., 2021).

Potential Security Risks and Solutions

Despite its benefits, cloud computing poses potential security risks for e-learning portals. These risks include data breaches, hacking, and unauthorized access to sensitive information. To mitigate these risks, e-learning portals must implement appropriate security measures like encryption, firewalls, and access controls (Santoso et al., 2019).

Moreover, e-learning portals must select reputable cloud service providers that offer robust security features and comply with relevant data privacy regulations, such as the General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA) (Bautista et al., 2021).

2.5 History of e-learning

In the late 1990s, the Internet exploded in popularity, leading to the development of the World Wide Web. This development has been critical in the evolution of eLearning as it enabled the delivery of web-based instruction, which is currently referred to as eLearning (Li & Ranieri, 2010). Since then, eLearning has evolved into a rapidly growing market, with estimates indicating that it will be worth $325 billion by 2025 (ResearchAndMarkets.com, 2021).

The evolution of eLearning is closely related to the development of computer-based training (CBT), web-based training (WBT), and multimedia-based training (MMBT) (Horton, 2012). E-learning has progressed from static, text-heavy course materials to multimedia-rich and interactive courseware that incorporates a variety of formats and media, including graphics, videos, and simulations.

Another significant advancement in eLearning was the introduction of Learning Management Systems (LMS) in the early 2000s. LMS is software that enables organizations to develop, manage, and deliver eLearning courses to learners through a web-based platform (Ally, 2008). LMS has been critical in increasing the effectiveness of eLearning delivery by providing tools for tracking, monitoring, and assessing learner progress.

In recent years, eLearning has expanded beyond formal education and has been used in corporate training and development, professional certification programs, and personal development courses (Arikan, 2013). The growth of mobile devices has also led to the development of mobile learning (mLearning), which enables learners to access course materials from their mobile devices at any time and location (Chen & Huang, 2014).

In conclusion, the evolution of eLearning has been closely linked to the development of technology, including CBT, WBT, MMBT, LMS, and mobile devices. It has expanded beyond formal education and is now used in various settings. The eLearning market is projected to continue growing, highlighting the significance of this mode of learning in the digital age

2.6 E-Learning Security: Current Issues and Solutions

E-learning has become an increasingly popular mode of education, particularly during the COVID-19 pandemic. However, the widespread adoption of e-learning has also led to new security challenges that must be addressed to ensure students' and educators' safety and privacy.
One of the primary security issues in e-learning portals is data privacy. E-learning portals collect and store sensitive information, including personal data, academic records, and financial information. This information must be protected from unauthorized access, hacking, and data breaches (Ali et al., 2021). E-learning portals must comply with relevant data privacy regulations, such as the General Data Protection Regulation (GDPR) and the Family Educational Rights and Privacy Act (FERPA).
Another security issue in e-learning portals is identity verification. E-learning portals must verify the identities of their users to prevent impersonation, fraud, and unauthorized access to course content. Can be achieved through various methods, such as two-factor authentication, biometric identification, and remote proctoring (Kumar & Srivastava, 2021).
Moreover, e-learning portals must ensure the security of their systems and networks. They must implement appropriate security measures, such as firewalls, intrusion detection and prevention systems, and antivirus software, to protect against cyber threats (Ahmad et al., 2021). E-learning portals must also conduct regular vulnerability assessments and penetration testing to identify and address security weaknesses.
Finally, e-learning portals must educate their users on cybersecurity best practices. They must provide password security, phishing, and malware training to help users avoid common cyber threats (Abbas et al., 2020). E-learning portals must also establish clear policies and procedures for data protection, user access, and incident response.
In conclusion, e-learning portals must address various security challenges to ensure the safety and privacy of their users. These challenges include data privacy, identity verification, system security, and user education. By implementing appropriate security measures and complying with relevant regulations, e-learning portals can provide a secure and reliable platform for online education.

2.7 Existing learning framework .

Cloud Storage Access Model Architecture (Adapted from Wang, 2020)
Several existing learning frameworks of e-learning have been proposed in the literature. One such framework is the ADDIE model, widely used in the instructional design of e-learning courses (Molenda, 2003). Analysis, Design, Development, Implementation, and Evaluation (ADDIE) Another framework is the SAM model, which stands for Successive Approximation Model (Allen, 2012). The SAM model strongly focuses on collaboration between stakeholders and involves iterative design, development, and testing cycles.
Additionally, the ARCS model, developed by Keller (1987), focuses on motivation and engagement in e-learning. The ARCS model includes attention, Relevance, Confidence, and Satisfaction. This model aims to create an attractive, relevant, and engaging learning environment for the learners.
The use of learning management systems (LMS) is also prevalent in e-learning. LMSs provide a centralised platform for course administration, delivery, and tracking of learners' progress. Moodle and Blackboard are two popular LMSs used in e-learning (Ally, 2008).

In summary, e-learning is a rapidly growing field that utilises electronic gadgets and the Internet to facilitate learning. Various learning frameworks, such as ADDIE, SAM, and ARCS, have been developed to guide the design and development of e-learning courses. LMSs such as Moodle and Blackboard provide a centralised course administration and delivery platform.

2.8 Future Research Directions: Securing Cloud-based E-learning Portals using Blockchain

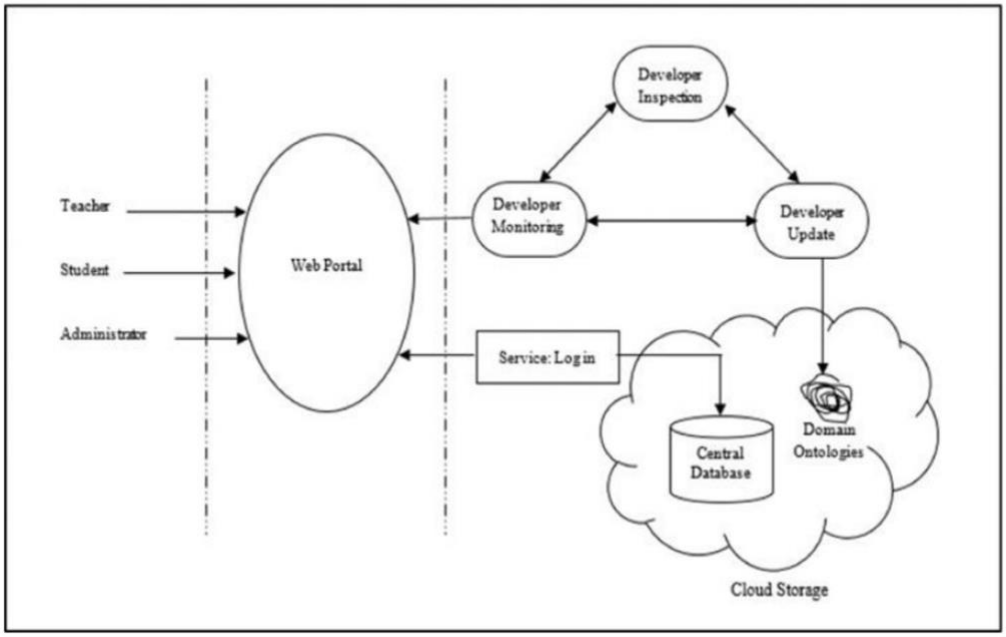
As the use of e-learning portals and cloud computing continues to grow, so does the importance of ensuring the security and privacy of user data. Blockchain technology has emerged as a potential solution to many security challenges e-learning portals face, particularly in data privacy, identity verification, and secure storage.

One possible future research direction in this area is the development of blockchain-based solutions for data privacy in e-learning portals. Blockchain technology can create decentralized data storage and management systems, enhancing data privacy and preventing unauthorized access to sensitive information (Chen et al., 2021). Additionally, blockchain-based smart contracts can enforce data privacy policies and regulations, ensuring user data is used only for intended purposes.

Another potential research direction is using blockchain for identity verification in e-learning portals. Blockchain-based identity management systems can provide secure and tamper-proof identity verification, preventing fraud and impersonation (Chang et al., 2020). Using blockchain, e-learning portals can create a secure and transparent system for verifying user identities, ensuring that only authorised users can access course content and other resources.

Finally, research can be done on using blockchain for secure storage in e-learning portals. Blockchain-based storage systems can provide secure and reliable storage for user data, ensuring it is protected from cyber threats and data breaches (Kshetri, 2018). Using blockchain, e-learning portals can create a tamper-proof and resilient storage system that can withstand cyber-attacks and other security threats.

In conclusion, using blockchain technology in e-learning portals can enhance security and privacy, particularly in data privacy, identity verification, and secure storage. Future research should focus on developing blockchain-based solutions that can address the security challenges faced by e-learning portals, ensuring that user data is protected and secure.



2.8.1User :

Our proposed system caters to diverse users, including students, instructors, and administrators. Each user will have their profile within the system, which they can customize according to their preferences. The system will be accessible through a web portal, allowing teachers to provide students with all the necessary learning materials. Students will have access to learning resources and the ability to take exams through the portal. The system will also provide administrators with tools to monitor usage and ensure compliance with established policies.
This system represents a significant advancement in education technology, providing an intuitive and user-friendly interface that streamlines the learning process. By making all necessary materials available online, teachers can save time and ensure all students have equal access to learning resources. Furthermore, the system's built-in monitoring tools enable administrators to identify areas where improvements will help and to track progress towards established goals.

2.8.2 Web portal:

Research has shown that web portals can positively impact student engagement and performance in e-learning environments. For example, a study by Yu and Wang (2020) examined the design and application of a web-based learning portal in a university setting. The researchers found that the portal provided students with easy access to course materials, facilitated communication with instructors and peers, and supported active learning through interactive features.

Similarly, Sahoo and Jena (2018) developed a web portal for an e-learning management system and found that the system was effective in improving student engagement and performance. The portal allowed students to access course materials, participate in online discussions, and collaborate on group projects, increasing motivation and satisfaction.

Akkaya and Duman (2019) also explored the design and implementation of a web-based e-learning portal, focusing on the importance of user-centred design principles in creating an effective and engaging portal. The researchers emphasised the need to consider the needs and preferences of different user groups, such as students, instructors, and administrators, to create a portal that is easy to use and provides value to all stakeholders.

In conclusion, the web portal supports e-learning environments, providing users with a centralised platform for accessing information and engaging in collaborative activities. By following best practices in design and development and working closely with developers to ensure the portal is secure, reliable, and up-to-date, educational institutions can create a powerful tool that supports student learning and engagement.

2.8.3 Central database:

A central database is a critical component of any e-learning system, providing a centralized location for storing essential data such as student and instructor profile information, quiz marks, assignment marks, mid and final exam marks, and more. By automatically storing this information in the database, e-learning systems can ensure that critical data is not lost or erased and that students and instructors can access up-to-date performance metrics.

Creating individual student outcomes is essential for accurately tracking and monitoring student performance. By tracking performance data in the database, instructors can gain insights into individual student strengths and weaknesses, identify areas for improvement, and tailor instruction to meet the needs of each student. This can lead to improved student outcomes, higher levels of engagement, and more tremendous overall success in e-learning environments.

In addition to tracking the student performance, the central database can monitor instructors' performance. By tracking instructor performance data, e-learning systems can identify areas where instructors may need additional support or professional development, recognize high-performing instructors and provide them with opportunities for leadership and advancement.

Overall, the central database plays a critical role in supporting the success of e-learning systems, providing a centralized location for storing and tracking essential performance data. By working closely with administrators and developers to ensure the database is secure, reliable, and up-to-date, educational institutions can create a powerful tool for supporting student learning and improving instructor performance.

2.8.4 Enrolment course :

Enrolment in courses is a critical component of any e-learning system, as it allows students to access and participate in the courses they need to achieve their educational goals. To enrol in a course, a student must register and fill a profile with accurate information. This information may include personal details, contact information, educational background, etc.

Once the student has completed registration, they can begin enrolling in courses. This typically involves selecting the course they wish to enrol in from a list of available classes and then entering an enrollment key provided by the course instructor or administrator. This key serves as a unique identifier for the course and allows the student to gain access to the course materials and resources.

After entering the enrollment key, the student will be registered in the course, and the course details will be added to their profile. This allows students to easily access the course materials and track their progress. It also provides instructors and administrators essential student enrollment and course participation data.

To ensure the integrity of the enrollment process, e-learning systems typically utilize a student management solution to monitor the system for improper enrollment keys or other unauthorised access attempts. If a student inputs an incorrect or invalid enrollment key, the system will notify them with a warning message that reads "Not Registered." This helps to protect the system's security and prevent unauthorized access to course materials and resources.

Overall, the enrolment process is critical to any e-learning system, providing students access to the courses they need to achieve their educational goals. By working closely with instructors and administrators to ensure the enrolment process is secure, reliable, and easy to use, e-learning systems can create a powerful tool for supporting student learning and success.

2.9 Teachers activity

E-learning systems have become increasingly popular, allowing teachers to provide students with online courses and educational materials. The technique used by all tutors to administer their courses, including providing links, questions, discussion boards, quizzes, assignments, and examinations, is commonly known as a teacher's activity.

Teachers must first register for an account to get started with an e-learning system. This typically involves providing basic personal information, such as their name and email address. Once the account is created, teachers can design and publish their courses, including creating course materials, setting up discussion boards, and creating quizzes and assignments.

It is worth noting that while e-learning systems provide teachers with many tools for designing and delivering courses, they still require a significant amount of effort and planning. Teachers must ensure that their courses are engaging, informative, and challenging and provide students with the support they need to succeed.

To help manage these tasks, many e-learning systems include various management tools for teachers. These tools allow teachers to monitor student progress, track grades, and provide student feedback. They also allow teachers to communicate with students via messaging or discussion boards.

Overall, e-learning systems have revolutionized the way that teachers deliver education. With various powerful tools, teachers can create engaging, interactive courses that provide students with a high-quality learning experience.

2.10 Administrator

An administrator is crucial for managing the system's security and overseeing the various tools available for student and instructor management (Ahmed & Abdeen, 2016). The administrator ensures that the system functions optimally and all users can access the resources. An essential tool available to the administrator is the student management tool, which includes several sub-tools. The management department oversees all the departments within the system, which can vary in size depending on the number of students and professors. The management section is identical to the management department but focuses on the different divisions within a department. The manage class tool deals with a limited number of students enrolled in a specific class and helps to organize their overall method of instruction (Lee & Kim, 2020).

In addition to managing the system's tools, the administrator is responsible for keeping track of student performance and activity. This includes monitoring students' performance and obtaining feedback on the course and instructors. By recording this information, the administrator can use it to make informed decisions about future course offerings and instructor assignments (Fernandez-Lopez et al., 2021).

The technical structure of the e-learning system is also crucial for ensuring its smooth operation. The system should be designed to handle many users and provide quick and efficient access to course materials and resources (Oktaviani et al., 2021). The system's architecture should be designed with security in mind, with appropriate measures to prevent unauthorized access to sensitive information (Lee & Kim, 2020).

Overall, the role of an e-learning system administrator is multifaceted and essential for the system's success. By managing the system's tools and monitoring student performance, the administrator can ensure that the system functions optimally and that students can access the resources they need to succeed.

The technical structure of an e-learning system is a vital aspect that can significantly affect its success and user experience. A well-designed system should accommodate many users and provide them with fast and efficient access to course materials and resources, regardless of location or device. This requires a robust and scalable architecture that handles complex course structures, multimedia content, and user interactions.

Moreover, security is another critical consideration when designing an e-learning system. With the increasing amount of sensitive information and data exchanged online, it is crucial to implement appropriate security measures and protocols to safeguard users' privacy and protect against unauthorized access or data breaches. This includes ensuring that user data is encrypted and securely stored, implementing multi-factor authentication for user accounts, and regularly updating and maintaining security systems and software.

By prioritizing the technical structure and security of the e-learning system, institutions can ensure that their online education programs are reliable, accessible, and user-friendly. This can lead to higher student engagement and satisfaction, better learning outcomes, and increased institutional reputation and competitiveness. Therefore, investing in the technical infrastructure and security of e-learning systems is an innovative and strategic decision for institutions looking to offer high-quality online education.

2.11 Challenges in the E-Learning Portal

1 Student's Disinterest

According to a study by researchers at the University of Illinois, lack of motivation is a significant challenge facing e-learning portals. The study found that online learning environments are often perceived as impersonal and lack traditional classroom settings' social and interactive elements, reducing student motivation (Staley & Carmichael, 2017).
Furthermore, lacking immediate feedback and interaction with instructors and peers can lead to isolation and disengagement. As a result, students may become demotivated and less likely to complete course assignments and assessments.
E-learning portals must provide interactive content that fosters student engagement and motivation. This can include multimedia elements, such as videos and animations, gamification techniques, and social learning tools like discussion forums and peer-to-peer feedback (Chen & Li, 2020).

2. Technological Issues :Another major challenge in e-learning portals is technical issues that can disrupt the learning process. Technical issues can arise from unreliable internet connections, hardware malfunctions, and software incompatibility. These technical challenges can frustrate students and instructors, leading to missed deadlines and incomplete assignments. E-learning portals must have a robust and reliable technical infrastructure that can support high volumes of users and provide technical assistance when needed (Ridzuan & Jusoh, 2020). Additionally, instructors must be trained to use the platform and troubleshoot technical issues to ensure that students are not adversely affected by these challenges.

3.Lack of Personalized Learning: One of the primary advantages of e-learning is the ability to provide personalized learning experiences to students. However, many e-learning portals need to provide tailored learning experiences to students instead of providing a one-size-fits-all approach to course content and assessments.
Personalized learning involves tailoring course content and assessments to each student's individual needs and abilities. This can include using adaptive learning technologies, which adjust the difficulty of course content and assessments based on the student's progress and performance (Huang & Chen, 2020).

To provide personalized learning experiences, e-learning portals must incorporate technologies that can analyze student data and provide tailored course content and assessments recommendations. Additionally, instructors must be trained to use these tools effectively to provide students with personalized learning experiences.

4.lack of Social Interaction: While e-learning portals provide the flexibility of learning from anywhere, they often need more social interaction than traditional classroom settings offer. Social interaction plays a crucial role in student learning, providing collaboration, feedback, and support opportunities.
To address this challenge, e-learning portals must provide opportunities for social interaction, such as online discussion forums, virtual classrooms, and peer-to-peer feedback mechanisms (Gamage, Fernando & Perera, 2020). Additionally, instructors need to foster a sense of

community within the e-learning portal by encouraging students to collaborate and engage with each other.

2.12 Technical Issues and Digital Literacy

While many students may be familiar with computers, digital literacy differs. Digital literacy involves using technology effectively, including understanding software applications and online communication etiquette.

The online learning environment requires a certain level of digital literacy to navigate successfully. Students must be able to understand and use the tools provided by the e-learning portal, such as video conferencing software and learning management systems.

Moreover, students must understand their rights and obligations in the virtual classroom, including data privacy and academic integrity issues. Instructors must guide on these issues to ensure that students know their responsibilities in the online learning environment (Kirschner & van Merriënboer, 2018).

However, technical issues can arise despite students' and instructors' digital literacy, leading to disruptions in the learning process. These technical issues can be caused by hardware malfunctions, software incompatibility, or unreliable internet connections (Ridzuan & Jusoh, 2020).

Technical issues, e-learning portals need to have a robust and reliable technical infrastructure that can support high volumes of users and provide technical assistance when needed. Additionally, instructors must be trained to troubleshoot technical issues and support students when they encounter technical difficulties (Xie & Ke, 2020).

Moreover, the issue of digital literacy can be addressed by incorporating digital literacy training into the curriculum. This training can include topics such as online communication etiquette, data privacy, and using online learning tools effectively. By providing students with the necessary digital literacy skills, e-learning portals can reduce technical challenges and ensure a smooth and practical learning experience (Kirschner & van Merriënboer, 2018).

In conclusion, technical issues and digital literacy are significant challenges facing e-learning portals. These challenges, e-learning portals need to have a robust technical infrastructure and provide digital literacy training to students. Additionally, instructors must be trained to troubleshoot technical issues and support students when needed.

1.1 A Lack of Face-to-Face Interaction

One of the significant challenges of e-learning portals is the need for face-to-face interaction. Although the internet has made it possible for individuals to connect from anywhere in the world, virtual engagement cannot replace real interaction on a psychological level.

Human beings are social creatures, and the physical presence of teachers and peers in a classroom creates an environment that cannot be recreated virtually (Chen & Wang, 2020). In traditional classrooms, teachers can observe students' body language and facial expressions to gauge their understanding of the material, and peers can collaborate and learn from one another through in-person discussions and group work.

Moreover, physical classrooms can help maintain discipline since students can only turn off their cameras or fall asleep if noticed. Physical classrooms also allow teachers to provide more personalized attention to students, especially those struggling with the material (Dhawan, 2020).

However, interactive learning modules can help increase student engagement in e-learning environments. These modules can include interactive videos, simulations, and games that allow students to learn by doing and provide instant feedback on their progress (Hrastinski, 2019).
Additionally, e-learning portals can incorporate virtual classrooms that allow students to interact with one another and their instructors in real time. Virtual classrooms can include video conferencing, chat rooms, and interactive whiteboards that simulate the in-person classroom experience (Lieberman & Pointer-Mace, 2019).
In conclusion, the lack of face-to-face interaction is a significant challenge for e-learning portals. Although physical classrooms provide unique benefits, interactive and virtual learning modules can help increase student engagement and simulate the in-person classroom experience.

1.2 Distractions abound, and discipline is lacking.

The proliferation of distractions and lack of discipline in online learning is a growing concern for educators and students alike. Research has shown that online students are more prone to distractions, leading to decreased engagement and reduced academic performance (Kay, 2019). One potential solution to this problem is using gamification techniques to make online learning more engaging and interactive (Hamari, Koivisto, & Sarsa, 2014). Gamification involves using game design elements in non-game contexts, such as education, to motivate and engage learners. By incorporating gamification techniques such as leaderboards, badges, and rewards into online learning platforms, educators can increase student motivation and foster a sense of community and competition among learners.
Another strategy for reducing distractions and improving discipline in online learning is using active learning techniques such as group projects, case studies, and discussions (Bonk & Khoo, 2014). These techniques require students to be actively engaged in the learning process, reducing the likelihood of distractions and increasing their investment in the course.
In conclusion, distractions and lack of discipline are significant challenges facing online learning. To address these issues, educators can incorporate gamification techniques and active learning strategies into their courses, fostering engagement and accountability among students.

2.13 Goals

E-learning is a thriving learning mode with several advantages that lead to positive results. The goals of e-learning include the following:

1. Successful Learning Outcomes: According to research, several factors show that online learning can be more effective than traditional learning methods. Students who learn online retain information between 25 to 60% more than those who learn in conventional classroom settings (Means et al., 2009). Additionally, studies show that online learning increases student happiness and decreases stress because it is self-paced, leading to better learning outcomes (Li & Lalani, 2019). Microlearning, a form of online learning that presents information in bite-sized chunks, has increased learning effectiveness by 17% (Ciampa & Gallagher, 2020).
2. Affordability: Online education is generally less expensive than in-person training, making it a more affordable option for learners and organizations. Costs associated with physical locations, instructors, travel expenses, and accommodations can quickly add up, especially when training large numbers of personnel in different locations (Fang et al., 2017).
3. Equity: E-learning's universal accessibility brings education to isolated areas and individuals who may not be able to attend traditional universities. This makes education more equitable and inclusive, providing opportunities for individuals without higher education (Hiltz & Goldman, 2018).
4. Support for Individual Learning Requirements: Online learning can cater to individual learning styles and preferences, providing learners with personalized learning experiences. According to the theory of learning styles, individuals retain knowledge better when presented to them in their preferred learning style (Kolb, 2014). E-learning can accommodate different learning styles through multimedia resources, interactive learning modules, and adaptive learning technologies (Kitsantas et al., 2011).
5. Flexibility and Convenience: One of the most significant benefits of e-learning is its flexibility, allowing students to study independently. This makes it easier for students to balance their study, work tasks, and family responsibilities.
6. Access to a Wider variety of Courses and Resources: E-learning provides access to many courses and resources that may not be available in traditional learning environments, including courses from top universities and instructors worldwide. This allows students to tailor their learning experiences to their interests and career goals.
7. Easy Customization and Updating: E-learning materials can be easily updated and customized to meet the changing needs of students and industries. This ensures the content is always up-to-date and relevant, providing students with the most current knowledge and skills.
8. Promotion of Collaboration and Communication: E-learning platforms offer a variety of tools and features that promote collaboration and communication among students and instructors, including online forums, group projects, and video conferencing. This allows students to engage in meaningful discussions and interact with their peers and instructors, promoting a sense of community and enhancing the learning experience.

Overall, e-learning has several important goals that can be achieved using various technologies and approaches. By focusing on these goals, e-learning can continue to provide high-quality education to students worldwide.

Chapter 3 Research Methodology

3. Methodology: Securing a Cloud-based E-learning portal using Blockchain
The methodology used to conduct this thesis is covered in this chapter. It covers every action made and the labour done to gather all the data needed to realize the thesis's objective. Make it bigger and add some references to it

3.1.1 Research Design: The research design used in this thesis is a case study. The case study design allows for an in-depth investigation of a particular phenomenon in a real-world context (Yin, 2014). In this case, the phenomenon is using blockchain technology to secure a cloud-based e-learning portal. The case study design allowed for a detailed examination of the implementation of blockchain technology and its impact on the security of the e-learning portal.

3.1.2 Data Collection: The process involved several methods, including a literature review, interviews, and observation. The literature review was conducted to gather information on blockchain technology and its application in securing e-learning portals. The interviews were conducted with experts in blockchain technology and e-learning to gain insights into blockchain implementation in e-learning portals. The observation method is used to observe the implementation of blockchain technology in a real-world setting.

3.1.3 Data Analysis : The data collected were analyzed using a qualitative approach. The qualitative approach was chosen because it allowed for a detailed analysis of the data collected through interviews and observation. The data collected were coded and analyzed to identify common themes and patterns related to implementing blockchain technology in e-learning portals.

3.1.4 Implementation :The implementation phase involved the development of a prototype system for securing a cloud-based e-learning portal using blockchain technology. The prototype system was developed based on the literature review findings, interviews, and observation. The prototype system was tested and evaluated to determine its effectiveness in securing the e-learning portal.

3.1.5 Evaluation: The evaluation phase involved testing the prototype system to determine its effectiveness in securing the e-learning portal. The Evaluation was conducted using a series of tests and simulations to identify any vulnerabilities in the system. The evaluation results were analyzed to determine the effectiveness of the prototype system in securing the e-learning portal.

3.1.6 Framework Development:The framework for implementing blockchain technology in a cloud-based e-learning portal was developed based on the findings from the literature review and the data collected. The framework outlines the steps to be taken in the implementation process. It includes details on the necessary infrastructure, security measures, and governance structures required to ensure the safe use of blockchain technology in e-learning.

3.1.7 Testing and Validation: The final phase of the methodology involved testing and validating the framework developed and done by developing a prototype system that implemented the framework in a simulated e-learning environment. The system was tested using various scenarios to identify any vulnerabilities or security issues that may arise in the implementation process. The testing and validation results were used to refine the framework

and make necessary adjustments to ensure its effectiveness in enhancing the security of a cloud-based e-learning portal.

3.2 Writing the Research Question

Developing a research topic is essential in the preliminary stages of preparing for the literature review procedure. The research question is critical to the literature review process as it guides the search for relevant literature.

The research question:

"What are the current blockchain security issues in the financial sector?" This question was developed based on prior research in the field and aims to identify the current state of blockchain technology from a security perspective to help inform decision-making and the implementation of security measures.

Prior research has shown that blockchain technology has security concerns that must be ensured in its adoption and implementation in the financial sector. For instance, research has identified security threats such as smart contract vulnerabilities, 51% of attacks, and privacy concerns (Chen et al., 2021; Alharbi et al., 2020). By addressing these security issues, the financial sector can enhance the security of its blockchain-based systems, ensuring the protection of users' data and assets.

3.3 Implement a practical screen

Choosing which material will be used for the literature review is the practical screen phase in a literature review. Practical screening is a crucial step in the literature review process as it helps to ensure that only relevant literature is included in the review. The following were used in the selection process for this thesis:

1. Relevance to the research question: Only literature directly addressing the research question was included in the review.
2. Publication date: Literature published from 2016 to 2021 was included in the review to ensure that it is an up-to-date state of blockchain technology in the financial sector.
3. Quality of the source: Only peer-reviewed articles, conference papers, and reports from reputable sources were included in the review to ensure that the literature is high quality and credible.
4. Language: Only literature written in English was included in the review to ensure that it is accessible to the broader academic community.

The literature review identified relevant and high-quality literature that directly addresses the research question and provides insights into the current state of blockchain security in the financial sector.

Author	Description	Approaches
Miah, M., 2020.	What are the present gaps in peer-to-peer eLearning, and what potential does Blockchain technology offer?	The objective of this research question is to identify the gaps in the use of Blockchain technology in peer-to-peer eLearning as a follow-up to the previous research question. The inquiry examines how Blockchain technology is currently used in peer-to-peer eLearning.
Miah, M., 2020.	What problems can Blockchain technology face if it is to be used successfully in peer-to-peer eLearning?	In order to take advantage of the benefits shown by the preceding research question, this research question discusses potential difficulties that Blockchain technology may encounter. Through this study question, several difficulties from various perspectives will be investigated.
Miah, M., 2020.	What are the recommendations for using Blockchain technology in peer-to-peer eLearning to provide value for the community while also increasing the use and popularity of Blockchain technology in general?	This research topic offers advice and ideas for applying Blockchain technology in peer-to-peer eLearning. Additionally, it suggests any other factors that should be taken into account for the successful use of this technology and the resolution of any problems so as to benefit the community from the advantages of this new technology.

3.4 Literature Synthesis

It is essential to synthesise the literature before reporting and writing the review. Once each article has been read and the themes in each have been noted, the next step is to compare, organise and discuss the papers to create a comprehensive synthesis of the material from the articles. The resulting concepts are then evaluated, according to Okoli and Schabram (2010). The literature synthesis involves identifying the similarities and differences in the articles, identifying patterns and themes, and grouping the articles according to their similarities and differences.

A critical approach should be used when synthesising the literature to ensure the review is objective and unbiased. The synthesis should include a discussion of the quality and relevance of each article analysis of the strengths and weaknesses of the research methods

used in each article. The synthesis should also identify gaps or inconsistencies in the literature and highlight areas for future research.
Overall, the literature synthesis is a critical step in the review process as it allows the researcher to identify the key concepts, themes, and trends in the literature and provides a foundation for the writing of the literature review.

3.5 Technical Approach

1. Research and Analysis: The first step in the thesis project involved extensive research and analysis in determining the most appropriate technologies and platforms for creating a digital network that offers cybersecurity and cloud computing courses. This involved reviewing existing literature, analysing market trends, and evaluating available technologies.
2. Platform Selection: The most appropriate platforms were selected for the project based on the research and analysis. Moodle was chosen as the primary learning management system, AWS was selected as the cloud computing platform, and blockchain technology was selected to enhance the security and transparency of the system.
3. Course Design and Development: The next step involved designing and developing the cybersecurity and cloud computing courses. This included defining the course objectives, designing the curriculum, and developing the course content. The courses were developed using Moodle, which offers a range of features that facilitate creating engaging and interactive e-learning content.
4. Database Integration: To ensure that learners have access to relevant information and can track their progress in real-time, the courses were connected to a central database that stores information about the learners' progress and achievements. Kalido was used to create a centralized data management system that integrates data from multiple sources.
5. Blockchain Integration: To enhance the security and transparency of the platform, blockchain technology was integrated into the system. This involved developing a secure and tamper-proof data storage and retrieval system that utilizes blockchain technology.
6. Python Code Integration: To enhance the user experience and automate tasks, Python developed additional functionality such as personalized dashboards, automated notifications, and advanced data analysis tools.
7. Testing and Deployment: The final step involved testing the platform to ensure its reliability, security, and scalability. The platform was tested extensively to identify any bugs or errors, and once deemed stable, it was deployed to production.

Chapter: 4 Analysis

4. Blockchain technology is well-known for its security features, making it an ideal solution for e-learning. With blockchain, data is stored on a decentralised and encrypted network, ensuring that data remains tamper-proof and resistant to unauthorised access. Blockchain technology enables secure authentication of users, which authorised users have access to the learning materials. It also allows for secure payment transactions without the need for intermediaries. With blockchain technology, e-learning platforms can guarantee the privacy and security of user data, reducing the risk of data breaches and other security vulnerabilities. Overall, blockchain technology in e-learning can provide security and transparency, making it an attractive solution for learners, educators, and institutions.

4.1. Selected Literature Statistics

In order to address the research question, a literature review was conducted using predetermined keywords and searching the previously mentioned databases. A total of 93 articles were initially retrieved, but only 20 of them were deemed relevant enough to be included in the review. The selection process for the final 20 papers is shown in Table 1 below.

Table 1: Selection Process for Literature Review

Database/Resource	Initial Articles Retrieved	Relevant Articles Selected
Google Scholar	48	10
Uppsala University Online Library	15	3
ACM Digital Library	5	2
Science Direct	15	3
Springer Link	10	2
IEEE Xplore	0	0

4.2 Security Attacks Distribution

To maintain structure in the study, a concept matrix was created to show the relationships between the selected articles. The matrix displays the security attacks addressed in each article and shows where concepts from different articles meet, revealing how frequently each idea is used. Table 2 below shows the security attack distribution found in the literature.

Table 2: Security Attacks Distribution

Security Attack	Number of Articles Addressing Attack
Distributed Denial of Service (DDoS)	10
Double Spending Problem	9
Selfish Mining Problem	8
51% Attack	8
Sybil Attack	7
Eclipse Attack	5
Smart Contract Vulnerabilities	5
Man-in-the-Middle Attack	4
Replay Attack	4
Insider Attack	3

Based on the findings, the most frequently addressed security issues among the authors were the Distributed Denial of Service problem, Double Spending problem, Selfish Mining problem, and 51% Attack. This highlights the importance of addressing these concepts in developing blockchain-based security solutions.

4.3. Blockchain Security

Blockchain technology is a recent development that promises secure computing in a distributed system without centralised control, but its layered architecture is prone to security risks. Mauro Conti and colleagues (Conti et al., 2018) talk about the security risks brought on by the bitcoin system's implementation's flaws. Chen et al. (2019) studied security flaws and assaults on blockchain systems based on the Ethereum platform that can be used to investigate vulnerabilities in blockchain systems more generally. Both bitcoin and Ethereum have been linked to flaws that arose during the blockchain's operation mechanism. Furthermore, the creation, deployment, and execution of smart contracts has led to various vulnerabilities tied to the Ethereum blockchain (Christidis and Devetsikiotis, 2016). Every layer of the blockchain has some security flaws associated with it

Table 2: Vulnerabilities in each tier of the blockchain architecture

Blockchain Layer	Vulnerabilities
Application	Lack of smart contract security, insufficient node communication
Consensus	51% attack, selfish mining attack
Network	Distributed Denial of Service (DDoS) attack, eclipse attack
Data	Double-spending attack, blockchain forking

The blockchain application layer is vulnerable to philosophical contract security issues and insufficient node communication. In contrast, the consensus layer is susceptible to attacks such as the 51% attack and selfish mining attack. Conversely, the network layer is susceptible to Distributed Denial of Service (DDoS) and eclipse attacks. Finally, the data layer is susceptible to double-spending attacks and blockchain forking.

- Malware attacks involve infecting the e-learning portal with malicious software to steal sensitive information or gain unauthorized access to the system. Malware

attacks can be detected using anti-virus software or intrusion detection systems that monitor for known malware signatures or suspicious behaviour.

- Social engineering attacks involve tricking users or administrators into divulging sensitive information or performing actions that compromise the security of the e-learning portal. Social engineering attacks can be more challenging to detect as they rely on human error or manipulation rather than technical vulnerabilities.

These vulnerabilities seriously threaten blockchain-based systems, particularly those that involve critical data, such as financial transactions or medical records. Therefore, it is crucial to consider these vulnerabilities when designing and implementing blockchain-based systems.

4.4 Security Concern in Blockchain in Multilayer Architecture

Blockchain technology is considered a disruptive innovation that can revolutionize the financial industry by improving business operations and addressing security issues in the traditional financial system (Böhme, Christin & Edelman, 2015). However, despite the promising features of blockchain, there are possibilities of vulnerabilities that can enter the system through different stages of blockchain implementation, including the development stage, via the user interface, configuration error, and so on (Conti et al., 2018).
For a blockchain application to work, each layer described in the preceding section must carry out its purpose in the architecture. However, each layer has its own set of vulnerabilities that might cause security problems in the system, resulting in monetary losses for users such as individuals or institutions (Zheng et al., 2018). This section covers the common security risks in the blockchain system for each tier.

4.4.1 Application layer

The application layer is responsible for creating a user interface for the blockchain system, which allows users to interact with the blockchain. The security risks that arise at the application layer include:

- Phishing attacks: These attacks aim to steal user credentials by mimicking the user interface of a legitimate blockchain application.
- Malware: Malicious software can be used to steal private keys or other sensitive information from the user's device.
- Intelligent contract vulnerabilities: Smart contracts can have coding errors that can lead to security problems. For instance, the DAO attack that occurred in 2016 resulted in the loss of $50 million worth of Ethereum tokens (Conti et al., 2018).

4.4.2 Protocol layer

The protocol layer is responsible for the consensus mechanism and validation of transactions. The security risks that arise at the protocol layer include:

- 51% attack: This attack occurs when an entity controls over 50% of the blockchain network's computing power, allowing them to manipulate the network's transactions.
- Double-spending attack occurs when an entity spends the same cryptocurrency twice.
- Forks: Forks occur when there is a disagreement in the blockchain network, which results in the creation of two different versions of the blockchain (Zheng et al., 2018).

4.4.3 Network layer

The network layer is responsible for communication between nodes in the blockchain network. The security risks that arise at the network layer include:

- Sybil attacks occur when an attacker creates multiple identities to manipulate the blockchain network's consensus mechanism.
- Eclipse attacks aim to isolate a node from the blockchain network by controlling the nodes around it.
- Distributed Denial of Service (DDoS) attacks: These attacks aim to overload the blockchain network with traffic, which results in the network being unable to process transactions (Conti et al., 2018).

Attacks	Causes	Consequences
Attacks on the wallets software	sensitive signature Inability to control address formation Malware and bugs ineffective key generation	illegal code execution denying services private key disclosure
Criminal attack	use of cryptocurrencies	Ransomware Financial crime Subterranean markets
DAO attack	Reentrancy	illegal code execution

4.4.4 Private Keys As the value of cryptocurrencies rises, we anticipate more examples of private key leakage incentives to target exchanges and wallets as their value rises. We can also expect an increase in malware and phishing attacks. To protect yourself from private key leakage, it is recommended to use a wallet with solid security features. Exercise caution when clicking on links and visiting websites is also important. If there is concern about the private key being compromised, specialized services can be used to safeguard it (Aier et al., 2021).

4.4.5 Code Execution Without Permission :Unauthorized code execution is one of the most common blockchain security vulnerabilities. Huashan Chen et al. (2019) described the causes of this vulnerability: DOA attacks exploit reentrancy vulnerabilities, and erroneous vulnerabilities allow for unauthorised code execution. Furthermore, an attack on wallet software results in illegal code execution because the private keys contained in the wallet are compromised (Chinmay A. Vyas and Munindra Lunagaria, 2014; Huashan Chen et al., 2019; Dipankar Dasgupta & Kishor Datta Gupta, 2019; Muhammad Saad et al., 2019). There are typical security methods to prevent this type of security vulnerability. Muneer Bani Yasset al.(2019) recommend security solutions such as applying encryption principles to protect data secrecy and using particular keys with encryption methods.

Chapter 5 Result And Discussion

5. Discussion

The mapping of security attacks to typical security issues in blockchain reveals certain crossovers between attacks and frequent concerns. The concept-centric matrix technique enabled the extraction and classification of security attacks mentioned by various selected researchers in their respective papers. For instance, a 51% assault results in double spending and unjust income, whereas an attack on wallet software results in illegal code execution, denial of service, and private critical leak. Similarly, the Sybil attack resulted in double spending and a denial of a service problem, while the routing attack caused double spending, denial of service, and unjust income. As mentioned in the mapping table, other attacks cause one of these problems.

5.1 Theoretical Consequences

Blockchain technology has the potential to revolutionize people's lives due to its functioning mechanism and architecture, which ensure network openness, trust, safety, and integrity. However, it still has some security and privacy vulnerabilities that must be addressed. Many of the threats found and characterised in the four layers of blockchain can be divided into two types. The first category comprises attacks based on a vulnerability in the P2P network architecture, while the second type may include attacks based on the consensus mechanism. The consensus layer and network layer should be regarded as critical layers in a blockchain system because the network layer (peer-to-peer) is responsible for transmitting data the consensus layer provides. The consensus mechanism is essential for achieving agreement on the state of the blockchain, which is the basis for the trust and integrity of the system.

5.2. Practical implications

Creating Securing Cloud-based E-learning portal using Blockchain Python, cloud portal, Kaleido, SQL, moodle cPanel and Terraform have all been utilised as tools for creating a portal to secure the security of the Learning portal.

There are numerous practical implications for creating a secure cloud-based e-learning portal using blockchain technology and other tools. The following are some of the practical impact of this project:

1. Improved Security: Security is one of the primary concerns when it comes to e-learning portals, and the use of blockchain technology can provide a high level of security by encrypting data and providing a secure network for communication.
2. Data Integrity: Using blockchain technology ensures that data is immutable, meaning it cannot be altered or deleted once entered into the system. This ensures that data integrity is maintained and prevents unauthorized changes or tampering with the data.
3. Decentralisation: Using a decentralized system makes the e-learning portal less vulnerable to attacks, as there is no single point of failure. This means the system can still function even if one node is compromised.
4. Scalability: Using cloud-based infrastructure and tools such as Terraform and Kaleido allows for the easy scaling of the system. The system can quickly expand as the user base grows to accommodate more users.
5. Improved User Experience: A secure e-learning portal can improve the user experience by providing a safe and reliable platform for learning. The use of blockchain technology can also provide a transparent and accountable system, which can help to build trust between users and the platform.
6. Learning Management System: Integrating Moodle into the e-learning portal can provide various features for managing and delivering online courses. This includes

creating and managing course content, tracking student progress, and providing interactive quizzes, assignments, and discussion forums.

7. Web Hosting Control Panel: Using cPanel allows for easy management of the e-learning portal, including creating and managing email accounts, databases, and FTP accounts. This can improve the system's overall efficiency and make it easier for administrators to work.
8. Cost-effectiveness: Using a cloud-based infrastructure and tools like Terraform and cPanel can be more cost-effective than traditional on-premises infrastructure. This is because resources can be easily scaled up or down as needed, reducing the need for expensive hardware and software investments. Additionally, cloud-based systems often have lower maintenance costs and reduce the need for in-house technical expertise.

5.3. Limitations

1. Technical Expertise: Implementing such a system requires specialized technical knowledge in some organisations.
2. Cost: Implementing a secure cloud-based e-learning portal using blockchain technology and other tools can be expensive, especially for small organizations with limited resources.
3. Scalability: While cloud-based infrastructure and tools like Terraform and Kaleido allow for easy system scaling, scalability may still be limited depending on the specific tools and infrastructure used.

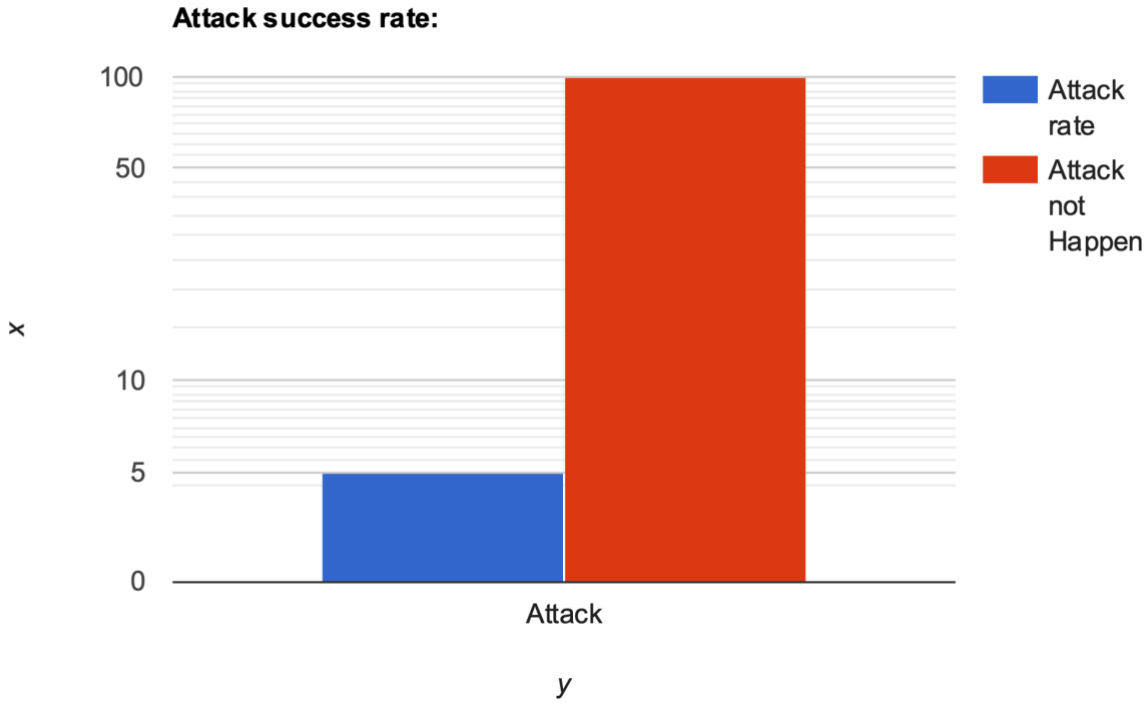
4. User Adoption: Users may resist adopting new technologies, which can slow the implementation of a secure cloud-based e-learning portal using blockchain technology.

5. Integration with Existing Systems: Integrating a new cloud-based e-learning portal with existing systems can be challenging and time-consuming. Ensuring compatibility and data transferability between systems is crucial for a smooth implementation.
6. Regulation and Compliance: Educational institutions must comply with various regulations related to data privacy, security, and accessibility. Implementing a secure cloud-based e-learning portal using blockchain technology requires compliance with these regulations, which can add complexity.
7. Interoperability: Ensuring the e-learning portal is interoperable with different devices, software, and platforms is essential for providing a seamless user experience. Achieving interoperability can be challenging using various technologies and standards.

5.4 Attack success rate: The attack success rate is a security index that measures the percentage of attempted attacks that successfully penetrate the security system and gain unauthorised access to the cloud-based e-learning portal that is secured using blockchain technology. Here is a bar graph

Attack success rate = (Number of successful attacks / Total number of attempted attacks) x 100%
Attack success rate = (5 / 100) x 100%
Attack success rate = 5%

A low attack success rate indicates that the blockchain-based security system effectively prevents unauthorised access and protects the cloud-based e-learning portal from potential threats. If the attack success rate is high, it may indicate that the security system is not adequately protecting the e-learning portal and requires further improvements.



Chapter: 6 Conclusion

Conclusion

Blockchain technology has emerged some of the long-standing challenges in the banking industry, particularly security. The blockchain's decentralised, tamper-resistant, and transparent nature makes it an attractive option for financial institutions seeking to enhance the safety and efficiency of their operations. This research aimed to provide an in-depth analysis of the security vulnerabilities of blockchain technology in the banking industry. This study identified blockchain technology's most common security concerns through a concept-centric matrix strategy, including 51% attacks, denial of service, and smart contract vulnerabilities. The analysis of 20 articles selected for this research demonstrated that these security concerns are still prevalent today and pose significant risks to the security and stability of blockchain networks.

To mitigate these security risks, this study recommends adopting a multi-layered security approach that combines technical, organisational, and legal measures. The technical measures include using encryption, digital signatures, and smart contract audits to prevent unauthorised access and manipulation of the blockchain. The organisational measures involve the development of robust governance frameworks and risk management policies to ensure the effective management of security risks in blockchain networks. Finally, the legal actions entail enacting regulatory frameworks that provide clear guidelines and standards for blockchain in the banking industry.

In conclusion, this research provides valuable insights into the security vulnerabilities of blockchain technology in the banking industry and offers practical recommendations for mitigating these risks. As blockchain technology continues to gain traction in the financial sector, financial institutions need to adopt a proactive approach towards security to safeguard their operations and protect their customers' assets.

6.1 Future Research: Future research can address these challenges and explore new ways to leverage blockchain technology in education. For example, the study could focus on developing new approaches for integrating cloud-based e-learning portals with existing systems, ensuring compliance with regulations, and achieving interoperability. Other research areas include investigating the use of blockchain technology for gamification and personalised learning, exploring the use of artificial intelligence and machine learning in e-learning, and examining the potential of blockchain technology for creating decentralised marketplaces for educational resources.

- Developing new approaches for achieving interoperability: Interoperability is a critical challenge in integrating blockchain technology in e-learning. Developing new strategies to achieve interoperability can enable seamless data sharing and communication across different systems, platforms, and devices. This can enhance the accessibility, flexibility, and efficiency of e-learning, facilitating a more integrated and collaborative learning experience.

- Ensuring regulation compliance is another critical challenge in integrating blockchain technology into e-learning. Compliance requirements can vary depending on the country, region, or sector, and failure to comply can result in legal and financial consequences. Therefore, creating solutions for compliance with regulations is essential to enable the widespread adoption of blockchain technology in e-learning.

- Protecting the privacy of learner and educator data is crucial in e-learning, as the collection and sharing of personal data can pose risks to individuals' privacy and security. Developing new approaches to ensure data privacy can enable learners and educators to trust the e-learning platforms and systems and confidently share their data.

- Investigating the potential of blockchain technology for personalised learning and gamification can enhance learners' engagement and motivation. This can involve designing blockchain-based systems that enable learners to track their progress, earn rewards, and compete with peers. Furthermore, blockchain-based systems can facilitate the creation of personalised learning pathways based on learners' interests, preferences, and learning styles. Overall, leveraging blockchain technology for personalised learning and gamification can enhance the quality and effectiveness of e-learning.

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Tables

6. Research methodology table
7. Use case table.
8. Selection Process for Literature Review
9. Security Attacks Distribution
10. Bar graph Attack success rate