CHAPTER 1

The Problem and its Background

Introduction

In the digital era, the integration of digital systems into academic operations has become an essential component of institutional efficiency and sustainability. Educational institutions are increasingly adopting innovative technologies to improve the management of research outputs, ensure data security, and enhance accessibility. At Pateros Technological College, particularly within the Research and Extension Department and the Institute of Information and Computing Technology (IICT), a significant volume of academic outputs such as capstone projects is produced annually. These research works serve as valuable learning materials and references for succeeding batches of students. However, the current practice of archiving these documents remains largely traditional, relying on printed copies and basic digital storage methods. This conventional system presents several challenges including data disorganization, redundancy, limited accessibility, and the risk of document loss or damage over time.

Historically, research documentation and repository systems in academic institutions have relied heavily on manual processes. While this approach may have been sufficient in earlier years, the increasing number of students and academic outputs has rendered manual storage inefficient and unsustainable. Problems such as misplacement of files, lack of standardized archiving formats, and difficulties in retrieving specific research works have become prevalent. The absence of a secure and verifiable digital system raises concerns regarding data integrity and intellectual property protection. In the Pateros Technological College, these issues hinder the effective utilization of past research materials, limiting opportunities for academic collaboration, innovation, and knowledge continuity within the institution.

To address this kind of challenge at Pateros Technological College, this study proposes the development of a "Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department." The proposed system introduces a decentralized and secure platform for managing and storing academic outputs. By leveraging blockchain technology, the system ensures transparency, immutability, and security of stored

data, thereby preventing unauthorized alterations or deletions. Each capstone project record will contain essential details such as the academic year, proponents, course and section, adviser, project category, abstract, and digital copy of the research. Once the data is encoded, the system automatically generates a QR code that encapsulates the project information. This QR code will be saved as a portable document format (PDF) file, which students can present during their capstone defense. Panelists can easily access the project's details by scanning the QR code, promoting efficiency and reducing the need for printed documents.

The integration of blockchain and QR code in the proposed system offers multiple benefits for both students and faculty members. It enhances accessibility and organization of research materials, minimizes data loss, and promotes environmentally sustainable practices by reducing paper usage. Moreover, the system reinforces data credibility by maintaining a verifiable chain of custody for each academic document. This approach not only modernizes the research repository of the IICT Department but also aligns with global trends in digital transformation and academic data management.

Above all, the Blockchain-Enabled Research Repository and Smart Asset Management System seeks to modernize and strengthen the existing research archiving process at Pateros Technological College. By addressing long-standing issues of inefficiency, disorganization, and data vulnerability, the system will serve as a foundation for a secure, organized, and technology-driven academic environment. This project underscores the institution's commitment to embracing innovative technologies that promote academic excellence, operational efficiency, and sustainability in the digital age.

Background of the Study

In today's learning environment at Pateros Technological College, technology is transforming how information is stored, managed, and accessed. At Pateros Technological College (PTC), particularly in the Institute of Information and Computing Technology (IICT) Department, a large volume of capstone projects is produced every year. The research outputs serve as valuable academic references that showcase students' creativity and technological

competence. However, the traditional method of managing the materials through printed copies poses several challenges such as disorganization, data loss, and limited accessibility.

As the number of capstone projects continues to grow, the manual storage and retrieval process has become inefficient and unsustainable. Administrators often face difficulties locating specific research works, while students have limited access to past studies that could aid their learning. Moreover, the lack of a secure and verifiable digital repository raises concerns regarding the authenticity and long-term preservation of academic data.

To address this kind of issues, the proposed "Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department" introduces a secure and decentralized digital platform for managing academic outputs at Pateros Technological College. Utilizing blockchain technology ensures data transparency, immutability, and protection against unauthorized modification. The system also generates a QR code for each project, allowing quick access to details such as the academic year, proponents, adviser, category, abstract, and softcopy of the research.

This innovation promotes a paperless, efficient, and environmentally sustainable approach to research management. By integrating blockchain and smart asset management, the system enhances data accessibility, security, and organization. Ultimately, it supports Pateros Technological College's commitment to digital transformation and academic excellence by providing a reliable and future-ready solution for managing research archives.

General Objectives

The general objective of this project is to develop a Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department. This system aims to provide a centralized, secure, and accessible platform for storing, managing, and retrieving data related to capstone projects. It seeks to modernize the institution's research management process by improving data organization, ensuring long-term preservation of academic outputs, and enhancing accessibility for administrators.

Specific Objectives

The Blockchain-Enabled Research Repository and Smart Asset Management System for

the Research and Extension Department, aims to digitalize the management of capstone projects, improving accessibility and efficiency.

The specific objectives of the study are the following:

A. To design and develop a web-based information system that provides secure storage and easy retrieval of capstone project records.

B. To create a centralized data bank that allows administrators to upload and access students capstone projects conveniently.

C. To provide administrators with an organized system for uploading, monitoring, reviewing, and archiving capstone projects.

D. To design a search bar that enables quick and accurate access to specific capstone projects based on title, and category of capstone projects.

E. To integrate a QR code feature that allows panelists to easily access and reference specific capstone projects through scanned codes.

F. To ensure data accuracy and consistency by minimizing redundancy and errors in storing and managing capstone project information.

Conceptual Framework

The goal of the study "Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department" is to develop an integrated system that utilizes web-based platforms to facilitate the quick, safe, and practical storage and retrieval of students' capstone projects.

In addition to storage and accessibility, the system continually enhances its design and incorporates features that make it more practical and user-friendly. Its goal is to create an easy-to-use interface that even administrators with defined technical knowledge can use.

It will enhance search and scanning QR code filter capabilities, enabling you to identify projects quickly by title or categories of the capstone projects. Additionally, security measures, data encryption, and regular system backups, also protect the information.
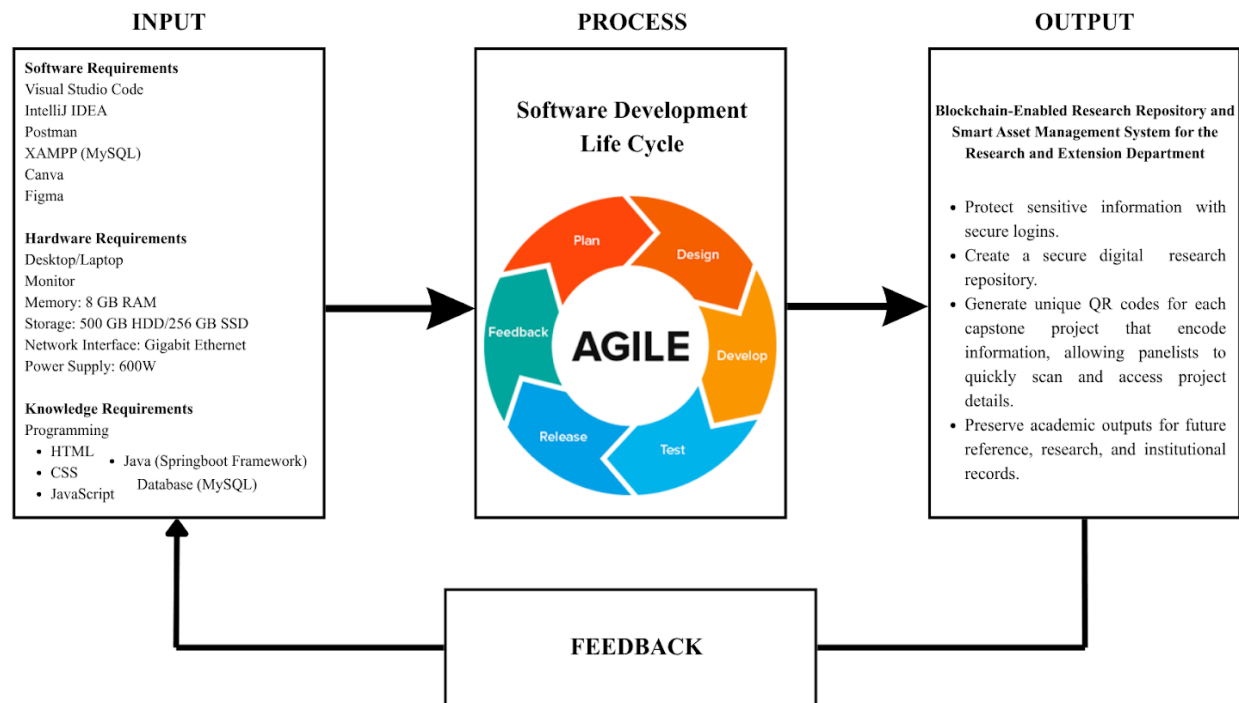
INPUT	PROCESS	OUTPUT
Software Requirements Visual Studio Code IntelliJ IDEA Postman XAMPP (MySQL) Canva Figma **Hardware Requirements** Desktop/Laptop Monitor Memory: 8 GB RAM Storage: 500 GB HDD/256 GB SSD Network Interface: Gigabit Ethernet Power Supply: 600W **Knowledge Requirements** Programming • HTML • CSS • JavaScript • Java (Springboot Framework) • Database (MySQL)	**Software Development Life Cycle** Plan — Design — Develop — Test — Release — Feedback AGILE	**Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department** • Protect sensitive information with secure logins. • Create a secure digital research repository. • Generate unique QR codes for each capstone project that encode information, allowing panelists to quickly scan and access project details. • Preserve academic outputs for future reference, research, and institutional records.

FEEDBACK

Figure 1: IPO (INPUT-PROCESS-OUTPUT)

The Research Repository and Smart Asset Management System was developed for the Institute of Information and Computing Technology (IICT) Department at Pateros Technological College through a systematic software development process. The input phase identified the system requirements, which included software tools such as **Visual Studio Code, IntelliJ IDEA, Postman, XAMPP (MySQL), Canva, and Figma**. The hardware requirements consisted of a **desktop or laptop computer with an 8 GB RAM, 500 GB HDD or 256 GB SSD storage, a Gigabit Ethernet network interface, and a 600W power supply.** Additionally, the development required programming knowledge in **HTML, CSS, JavaScript, Java using the Spring Boot framework and a Database (MySQL)** The process followed the System Development Life Cycle (SDLC), progressing through the stages of planning, design, development, testing, release, and feedback. The output is a fully operational, secure, web-based system designed to store, manage, and protect all institutional capstone data. It features user

authentication through secure logins and incorporates a unique QR code generation mechanism to facilitate efficient project access and ensure the preservation of academic outputs.

Significance of the Study

The development of the Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department holds significant value in enhancing the efficiency, transparency, and security of academic research data and institutional assets. This system will streamline the management, storage, and retrieval of research outputs while ensuring data integrity through blockchain technology. The study is essential for the following stakeholders:

PTC Administrators

This study will enable administrators to efficiently manage and organize research records and institutional assets. By utilizing blockchain for secure data storage, the system ensures transparency, prevents tampering, and supports systematic archiving and convenient retrieval of institutional research outputs.

PTC Students

This study will provide students with a reliable digital platform to store and access research documents. It will serve as a resource for reference and innovation, helping them gain insights from past works, avoid duplication of research topics, and foster originality in future studies.

PTC Panelists

This study will assist panelists and faculty researchers by providing a well-organized and trustworthy research repository. Through blockchain-backed data, panelists can rely on accurate and authentic references during proposal reviews, evaluations, and research consultations, even without direct system access.

Future Researchers

This study will serve as a valuable reference for future researchers who aim to enhance academic data management systems or explore blockchain applications in education. It can guide them in improving similar web-based platforms focused on research preservation, asset management, and data security.

Scope and Limitation

Scope

- This study will focus on the development of a web-based information system designed to manage and store capstone projects for the Institute of Information and Computing Technology (IICT) Department.

- The scope of this research includes the integration of a Quick Response (QR) Code feature, which allows panelists to conveniently view the student's capstone proposal during the defense day.

- This study will cover the implementation of administrative functions that enable authorized administrators to upload, edit, and delete capstone information, as well as manage project details such as title, abstract, description, author, year, status, and proponents.

- The study will also focus on ensuring data security through a role-based access control system, where roles are divided between administrators and users to prevent unauthorized access to the system's database.

- The scope of this study includes an account management module that allows administrators to log in using valid credentials such as an email address and password.

- This study will include the development of a "Forgot Password" feature to assist administrators in recovering their accounts in case they forget their login credentials.

Limitation

- This study is limited by its restriction to the Institute of Information and Computing Technology (IICT) Department and its focus only on capstone-related project information, such as capstone proposals and approved capstone projects.

- This research is limited by its user access scope, as only authorized panelists will be granted permission to view capstone proposals, while administrators will maintain complete control over the system.

- The study will focus solely on the storage, addition, retrieval, and basic management of capstone project information, excluding other academic or institutional data.

- This research will be conducted and tested exclusively within Pateros Technological College; therefore, testing outside the institution is not included in the study.

- The study is limited to web-based platforms that require internet access for operation. Consequently, the system cannot function offline.

Definition of Terms
- **Technical Terms**

Authentication - The process of verifying the identity of a user before granting access to a system or resource.

Blockchain Enabled - A decentralized digital ledger technology that securely records transactions across multiple computers, ensuring integrity, and transparency of data.

Data Encryption - Security process that converts data into a coded format to prevent unauthorized access.

Data Retrieval - The process of obtaining specific information or data from a database.

Database - A software application that runs on a web server and is accessed through a web browser using the internet.

QR Code (Quick Response Code) - A type of two-dimensional barcode that can store information and can be scanned using smartphones or QR scanners to retrieve data quickly.

Smart Asset Management System - Technology-based solution that automates the organization, monitoring, and preservation of institutional assets through digital platforms.

User Interface (UI) - The visual part of a system through which users interact with software or an application.

- **Operational Terms**

Administrator - Refers to the authorized user responsible for managing the system, including uploading, editing, and deleting capstone project information.

Capstone Project - A final academic project required of students in the IICT Department of Pateros Technological College, which demonstrates their skills and knowledge through a technological or research-based output.

Development - The process of building and maintaining the Web Based Institute of Information and Computing Technology Department of Pateros Technological College and web applications, encompassing a wide range of tasks from the technical creation of a site to its ongoing performance.

Forgot Password - A system function that helps users recover or reset their password if they forget their login credentials.

Search and Filter Functionality - A feature within the system that allows users to quickly locate specific capstone projects using criteria such as title and category.

Student User - Refers to the IICT student who utilizes the system to upload or access information related to their capstone project.

System Login - The process where an authorized user enters their credentials (email and password) to gain access to the system's main interface.

CHAPTER 2

Review of Related Literature and Studies

Introduction

This chapter presents the local and foreign literature and studies related to the development of a web-based information system for storing academic records. The studies reviewed highlight key concepts such as digital archiving, security, centralized storage, and improved data accessibility in educational institutions. These references help the researchers understand effective system features and guide the enhancement of the proposed E-Capstone Storage Data Bank to ensure secure, organized, and efficient management of capstone project files.

Foreign Literature

In recent years, the rapid advancement of digital technologies has transformed how academic institutions store, secure, and manage information. The growing volume of academic data has increased the need for systems that can ensure authenticity, accessibility, transparency, and long-term preservation. In response, modern researchers have explored emerging technologies such as blockchain, QR codes, and data repository frameworks to address issues of data tampering, record loss, and inefficient asset management. These developments have shaped various digital solutions across sectors, including education, research, and facilities administration. To understand these advancements, several foreign studies have emphasized innovative approaches in data protection, academic documentation, and asset security.

[1] According to Turamari (2022), the article "Application of QR Code in Academic Libraries: A Study" discusses how QR code technology enhances user experience in library services by providing instant access to digital resources. The study highlighted that QR codes enabled students and researchers to retrieve academic materials more quickly by simply scanning labels, reducing the time spent locating physical references. The author emphasized that using QR codes also improved library navigation, catalog searches, and information dissemination.

Furthermore, integrating QR codes helped bridge the gap between physical and digital library functions, making academic resources more interactive and accessible. The findings also demonstrated that QR code systems encouraged user engagement by offering a convenient gateway to library instructions, online journals, and e-books.

Overall, the study illustrated that digital tools can enhance academic services, improve information delivery, and support technology-driven learning environments.

[2] As stated by Bhaskar et al. (2020), the article "Blockchain in Education Management: Present and Future Applications" explains how blockchain technology can enhance transparency, accountability, and security in academic operations. The study emphasized that blockchain enables tamper-proof records, making it helpful in securing student credentials, certifications, and institutional documents. By adopting decentralized data structures, schools can minimize fraud and unauthorized alterations.

Moreover, the immutability of blockchain gives administrators greater confidence in managing academic archives and validating institutional records. In addition, blockchain enables secure information exchange between institutions, supporting collaboration and verification processes.

Overall, the study concluded that blockchain solutions can play a long-term role in modernizing education systems by strengthening digital trust and data integrity.

[3] In accordance with Zibani et al. (2021), the study "A Systematic Review of Faculty Research Repositories at Higher Education Institutions" examines how digital repositories organize, preserve, and distribute scholarly works. The findings revealed that universities rely on repository systems to maintain research visibility, support academic collaboration, and ensure long-term storage of intellectual outputs. These repositories serve as centralized platforms that improve the discoverability of research collections.

In addition, it also emphasized that effective repository management requires proper metadata, indexing, and access protocols to support both archiving and retrieval. The author observed that well-designed repositories help promote institutional identity by showcasing research productivity to broader audiences.

Overall, the study concluded that research repositories are essential tools for preserving academic knowledge and supporting digital scholarship in higher education.

[4] Based on Tavakoli et al. (2023), the article "Blockchain-Based Digital Twin Data Provenance for Predictive Asset Management in Building Facilities" explores how blockchain maintains transparency and traceability in asset-related data. The study explained that integrating blockchain with digital twin models allows facility managers to verify asset history and prevent data manipulation. By using immutable ledgers, organizations can predict maintenance needs and extend asset life cycles.

Additionally, blockchain strengthens data provenance, ensuring that asset information remains authentic throughout its lifespan. This approach also enables better decision-making by providing accurate records of performance, usage, and condition.

Overall, the study emphasizes that blockchain-enabled asset management can support reliable monitoring systems for institutional facilities and infrastructure.

[5] As mentioned by Madhurani et al. (2025), the book chapter "Blockchain-Based Research Data Repository" discusses how blockchain can secure research records by providing decentralized storage and verifiable data sharing. The study highlighted that blockchain safeguards academic outputs from tampering, unauthorized access, and data loss. By utilizing distributed ledgers, researchers can maintain trust in stored documents.

Also, blockchain features such as encryption, consensus mechanisms, and timestamping support reliable academic preservation, ensuring that data deposited in repositories remains authentic and transparent to stakeholders.

Overall, the study indicated that blockchain-based repositories can enhance research reliability by ensuring secure archival management.

[6] As indicated by Olatoye et al. (2024), the study "Blockchain in Asset Management: An Extensive Review of Opportunities and Challenges" provides an overview of blockchain applications for managing institutional assets. The study found that blockchain improves asset tracking, reduces manual errors, and enables real-time verification of asset histories. This system enhances accountability in monitoring inventories and resources.

In addition, blockchain enables faster audit processes by providing transparent transaction records for assets. With decentralized tracking, institutions can maintain accurate documentation free from unauthorized alterations.

Overall, the study concluded that blockchain-based asset management offers improved traceability and operational efficiency for various organizations.

Local Literature

[7] According to Infomax Systems Solutions and Services, Inc. In the Philippines, numerous institutions continue to depend on physical documents for recordkeeping making digitization an essential move toward operational modernization by converting paper records such as legal contracts and land titles into digital archives the organizations can ensure their preservation while improving accessibility and management efficiency. Converting traditional archives into digital form offers a practical and secure solution for minimizing paper consumption while improving record management.

[8] According to Bicol University 2025, The system is a digital platform developed to store, manage, and retrieve academic records of the students and It aims to efficiently record management processes by minimizing reliance on physical documents and enhancing the efficiency, accuracy, and speed of services provided to students and stakeholders.

[9] According to Archive 2024, the educational organizations manage employee files, financial documents, student records, education compliance documents, and various forms, which are primarily stored on paper, making the processes to manage them inefficient. Their study shows it reduces all document management challenges and helps educational institutions to save time in retrieving and managing documents and documents are centrally controlled and securely stored in a cloud environment.

[10] According to the Polytechnic University of the Philippines and the National Commission for Culture and the Arts (NCCA) 2022, the PHDH project emphasizes the importance of collecting, preserving, and providing access to creative and cultural works during the pandemic. This reflects how digital archiving systems support in safeguarding valuable records and making them accessible to researchers and the public, similar to how the present study aims to store and preserve academic outputs from previous capstone projects.

[11] According to Naif Albishri 2034, digital archiving allows institutions to preserve and highlight significant milestones from the past which ensure continuity in the academic experience by giving access to historical materials although digital preservation makes information more accessible it also raises questions regarding the accuracy and dependability of data. These insights reflect the significance of developing, like the suggested E-Capstone Data Bank, that guarantees academic records authenticity and long-term preservation in addition to digitizing them.

[12] According to DocByte 2023, Digital archiving is the process of storing and managing information in digital format for easy access and protection to help keep important data from loss, damage, and unauthorized changes with the technology and the internet, storing and finding files has become faster and simpler. Digital archives make old data easy to access and maintain data accuracy, and support better decision making. It plays a big role in keeping information available for future use while ensuring it stays complete and secure.

Foreign Studies

[13]According to Shrestha and Vassileva (2019), blockchain technology has emerged as a promising tool for transforming data management across multiple fields such as healthcare, agricultural research, and tourism. Within the research community, the authors emphasized that a blockchain-based system can create a proof of ownership and provenance for research outputs, allowing users to share data securely without losing control or ownership. This system ensures transparency by enabling users to monitor who accesses their data and for what purpose. The study utilized the Technology Acceptance Model (TAM) to examine behavioral factors influencing the intention to use blockchain-based research data-sharing platforms. Findings revealed that system quality and perceived enjoyment had a stronger impact on perceived usefulness, while perceived ease of use showed a weaker relationship. The authors concluded that understanding these behavioral factors is crucial to promoting the adoption and sustained use of blockchain-enabled research systems.

Moreover, the behavioral framework discussed by Shrestha and Vassileva provides valuable insight into how user perception and system quality can influence the acceptance of blockchain-based repositories in academic environments. While their study focuses on user adoption and data sharing, the present research extends these principles to include smart asset management, combining both research data preservation and institutional asset tracking within a blockchain-enabled framework.

[14]Likewise, Sharma and Gupta (2024) Blockchain-enabled asset management: Opportunities, risks and global implications, blockchain technology has emerged as a transformative force in asset management by improving efficiency, transparency, and global accessibility. Through decentralization, it eliminates intermediaries, lowers operational costs, and accelerates transaction processes. The integration of smart contracts and distributed ledger technology enhances accuracy, security, and ownership verification, while asset tokenization enables fractional ownership and broader participation. However, challenges such as regulatory uncertainty, cybersecurity risks, and ethical issues, including data privacy and environmental impact, remain barriers to full adoption. The study emphasizes that with proper implementation,

blockchain can redefine traditional asset management systems into more secure, transparent, and inclusive platforms.

Furthermore this study is related to the present research titled "Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department" as it supports the integration of blockchain for managing institutional assets efficiently and securely. The findings provide a strong foundation for the proposed system, which aims to utilize blockchain's transparency and decentralization features to monitor and manage both digital and physical assets within a research and extension context. By adopting similar blockchain principles, the system can enhance accountability, data integrity, and accessibility of research outputs and institutional resources.

[15]According to Al-Adwan, Al-Adwan, and Berger (2023), the implementation of blockchain technology—particularly smart contracts—within the Land Registry and Survey Department in Jordan plays a significant role in promoting sustainable development. The study utilized a quantitative, cross-sectional design involving 12,450 employees, with a sample of 448 respondents, and employed Partial Least Squares Structural Equation Modeling (PLS-SEM) for data analysis. The results indicated that blockchain features such as Security and Fraud Prevention, Efficiency and Automation, Regulatory Compliance, Transparency and Trust, and Accessibility and User Experience positively influence sustainable development outcomes. However, the researchers also emphasized challenges including the need for technical expertise, appropriate regulatory frameworks, and high initial implementation costs. The model explained 77.6% of the variance in sustainable development, confirming blockchain's potential to improve land administration efficiency and accountability.

This study is relevant to the present research titled "Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department" as it demonstrates how blockchain technology can enhance transparency, security, and efficiency in institutional management systems. Similar to land registries, research repositories also require data integrity, traceability, and decentralized control to maintain trust and accountability. The findings support the integration of smart contracts and blockchain mechanisms in academic and

research institutions, ensuring that digital assets such as research outputs are securely stored, transparently managed, and sustainably maintained for long-term institutional growth.

[16] According to Onwuegbuzie and Adu (2024), in their work "Development of a Responsive WebBased Final-Year Project Repository System (FYPRS) for Nigerian Tertiary Institutions," they developed a responsive repository that allows students and faculty to upload, view, and manage final-year project reports online. The study highlighted the importance of responsive design, user authentication, and cloud storage integration for maintaining system efficiency and accessibility across devices. Their findings reinforce the concept of a secure, user-friendly, and centralized digital repository for academic purposes.

[17]According to Ullah and Khan (2021), the traditional education systems in developing countries have been significantly improved through the integration of distributed ledger technology (DLT) such as blockchain. The study explored the key factors influencing the intention of educational institutions to adopt blockchain for e-learning and smart education environments. The researchers proposed an expanded Technology Acceptance Model (TAM) by incorporating elements of the Diffusion of Innovation Theory to better understand adoption behavior. Using an online survey and structural equation modeling, the study revealed that compatibility is a major factor that affects the adoption of blockchain in smart learning settings. The results also indicated that technological innovation and perceived usefulness influence decision-making among educational administrators. This research provides an expanded framework for understanding how educational institutions in emerging economies can adopt blockchain to improve accountability, transparency, and digital learning experiences.

[18] According to Exploring the Implementation and Impact of Blockchain Technology on Student Academic Data Management in Higher Education by Ainan Sekartika & M. Dirga Leandro (2024), blockchain technology was analysed in the context of higher education student data management. Their study found that blockchain's decentralised, secure and immutable ledger architecture offers substantial benefits in enhancing data integrity, transparency, and student empowerment through self-sovereign identity systems. The research also highlighted the challenges of implementation including technical complexity, scalability, interoperability and regulatory compliance.

[19] In accordance with Kim and Park (2022), electronic portfolios (e-portfolios) have become essential tools for students and lifelong learners to digitally showcase their skills and achievements. However, most existing e-portfolio systems rely on centralized institutions and trusted third parties for credential verification, which poses security and privacy concerns. To address these issues, the authors proposed a consortium blockchain-based e-portfolio management system that ensures decentralization, authenticity, and privacy preservation. By utilizing smart contracts, learners are given full ownership and control over their digital credentials, while potential employers can verify e-portfolio data without intermediaries. The system employs decentralized identifiers (DID) and verifiable credentials (VC) for authentication, ensuring tamper-proof, traceable, and accountable transactions. Their prototype, implemented using the Quorum blockchain, proved to be both secure and efficient, providing a feasible approach for reliable credential management.

Also the study demonstrates how blockchain can secure digital records, verify authenticity, and ensure decentralized control of information. Similar to the e-portfolio model, the proposed system seeks to allow researchers and administrators to store, verify, and share research outputs securely within an academic environment.

Overall the principles of decentralization, transparency, and user ownership found in Kim and Park's study provide valuable insights into developing a blockchain-based research repository that guarantees the integrity and reliability of academic documents and institutional assets.

Local Studies

[20] According to Ilisan (2025), the use of Blockchain and Internet of Things (IoT) technology is essential for guaranteeing transparency and integrity in the supply chains for halal products. Their analysis draws attention to the differences in the adoption of these technologies between the Philippines, Indonesia, and Malaysia. Through bibliometric analysis, the researchers found that while the Philippines has not done much study or applied Blockchain and IoT to preserve product authenticity and traceability, Malaysia and Indonesia have done so successfully. The authors suggest encouraging scientific collaboration, promoting technical innovation, and creating supportive regulations to fortify the halal business in order to close this gap. The report highlights how halal supply chain management may greatly improve transparency, traceability, and confidence by utilising these cutting-edge technology.

[21] As mentioned by Rodriguez (2024) asserts that the combination of Artificial Intelligence (AI), Blockchain, Cloud Computing, and Data Analytics collectively known as ABCD technologies has the potential to significantly improve operational efficiency, security, and decision-making in a number of Philippine industries, including healthcare, agriculture, finance, and education. The report offers a thorough analysis of the literature on the uptake and effects of these technologies in the nation. Notwithstanding their apparent advantages, the study points out that obstacles like inadequate infrastructure, a lack of qualified personnel, and legal restrictions prevent their broad adoption. To optimise the advantages of ABCD technology integration in the Philippines, the author highlights the necessity of increased policy support and workforce development.

[22] Based on Soares et. al (2024) investigated the creation of a Smart University paradigm, where technology improves learning, collaboration, and operational efficiency in higher education, taking inspiration from the Smart City concept. A Technology Management Framework is suggested in the report to help Philippine universities make the shift to Smart Universities. Additionally, it evaluates how prepared and flexible students, teachers, administrators, and IT specialists—especially in Metro Manila—are to adopt this new paradigm. The results highlight how crucial stakeholder involvement, institutional readiness, and digital infrastructure are to a successful Smart University integration.

[23] As stated by Sobejana and Lalisan (2019), to help Higher Education Institutions (HEIs) manage academic outputs more effectively, they created an electronic archive for research and capstone projects. The project, which was carried out at the Southern Philippines Agri-Business and Marine and Aquatic School of Technology, used survey-based assessments and a modified waterfall model to create a safe and easy-to-use online system for managing, storing, and retrieving student work. Fifty respondents' comments revealed a high degree of satisfaction with the system's usability, functionality, and dependability, indicating its efficacy in assisting the institution's research data administration.

[24] In accordance with Laguador et. al (2016), to improve faculty and student access to research outputs, to create and assess an institutional research repository utilising a content management system. Using WordPress as its base, the project integrated a research portal into the LPU-Batangas website, making it simple to create and manage webpages without the need for sophisticated technical knowledge. The evaluation's findings showed that the system was very functional, dependable, and easy to use. The portal was praised by both staff and students for its usefulness and ease of use in assisting with institutional research.

[25] The study on e-AIMSS (Electronic Asset Inventory and Management System in School) for Resource Optimization and Organizational Productivity focused on developing an electronic property inventory system designed to optimize school resources and ensure equitable access to materials for learners. Guided by the ISSO framework (Ignite, Strategize, Systematize, Operationalize) and a Logical Framework, the project was developed using the waterfall model and underwent alpha and beta testing. A t-Test was used to evaluate its effectiveness. Results revealed that real-time property monitoring significantly improved custodianship, while system digitalization enhanced reliability, efficiency, and usability compared to manual methods. The system also encouraged stakeholder engagement, supported budgeting and audits, and strengthened transparency and accountability within the institution.

Ahmad, A. (2023). e-AIMSS (Electronic Asset Inventory and Management System in School) for Resource Optimization and Organizational Productivity. International Journal of Multidisciplinary Educational Research and Innovation. 1(3), 121-139. https://doi.org/10.5281/zenodo.8326056.

Synthesis

In the title "Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department" the reviewed literature and studies, both local and foreign, emphasize the life-changing role of blockchain technology and repositories in enhancing data management, transparency, and institutional efficiency. Foreign literature highlights blockchain's ability to ensure data integrity, security, and traceability, as shown in studies by Bhaskar et al. (2020), Madhurani et al. (2025), and Tavakoli et al. (2023). Likewise, research repositories and QR code systems (Zibani et al., 2021; Turamari, 2022) demonstrate improved accessibility and digital engagement in academic environments.

Local literature and studies reflect the Philippines growing shift toward digital transformation in recordkeeping and asset management. Institutions such as Bicol University (2025) and PUP (2023) show how digital archives preserve academic outputs, while projects like e-AIMSS (Ahmad, 2023) and the cloud-based repository by Alvez (2022) highlight the benefits of automation and real-time monitoring in institutional operations.

Overall, the synthesis reveals that integrating blockchain with research repositories and asset management systems promotes secure, transparent, and efficient handling of institutional data. It addresses common issues such as data tampering, record loss, and inefficient tracking. The collective findings provide a strong foundation for the proposed Blockchain-Enabled Research Repository and Smart Asset Management System, which aims to ensure trustworthy data management, enhance operational transparency, and support long-term institutional sustainability.

CHAPTER 3

Research Design and Methodology

Methodology

This study utilized a qualitative research approach to examine the design and implementation of a Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department. The research analyzed current practices in research data management and asset tracking, identifying limitations in security, accessibility, and operational efficiency.

Research Design

The research design for the Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department focuses on exploring and evaluating a blockchain-based solution to improve research data management and institutional asset tracking. This approach provided detailed insights into system design, functionality, and effectiveness in enhancing data security, transparency, and operational efficiency.

The study utilized a qualitative research approach to evaluate the Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department. By using comprehensive qualitative data, the study provided a thorough evaluation of the system, offering insights into both its contextual relevance and practical applications. This approach demonstrated the system's effectiveness in streamlining workflows, ensuring reliable management of research outputs, and enhancing overall institutional processes for data and asset management.

Research Development

This chapter discusses the systematic process involved in the design and development of the Blockchain-Enabled Research Repository and Smart Asset Management System for the

Research and Extension Department of Pateros Technological College. It details the step-by-step development approach, from gathering requirements and identifying user needs to system design, testing, and implementation. The research development followed the Agile and Prototype models, allowing iterative feedback and continuous system enhancement to ensure that the final output meets both functional and user requirements.

Requirements Gathering

The first phase of the system development process was the plan gathering stage. This step aimed to identify the technical and functional needs of the institution in managing capstone projects within the Research and Extension Department. To accomplish this, the researchers conducted interviews and informal consultations with administrators of the Institute of Information and Computing Technology (IICT).

The gathered information focused on addressing the problems identified in Chapter 1, such as data disorganization, redundancy, and lack of accessibility. The primary requirements include:

- A secure and decentralized digital repository for capstone projects.
- Integration of blockchain technology to ensure immutability, transparency, and protection of academic data.
- QR code generation for every uploaded research file for easy retrieval and access during defenses.
- User authentication through administrator logins to prevent unauthorized access.
- A search and filtering function to locate specific research titles efficiently.
- A user-friendly interface that simplifies creating, uploading, viewing, and archiving research materials.
- Through this process, the researchers obtained a clear understanding of both the technical and operational needs that the system should address.

Identification of User Needs

Understanding the needs and expectations of the system's primary users was essential to developing a practical and user-centered repository. Consultations were conducted among the Research and Extension staff to determine how the system could improve the daily tasks.

- Improved Accessibility - Users require a centralized and organized system to store and retrieve capstone projects easily.
- Enhanced Security - Blockchain integration ensures the authenticity of stored files and prevents unauthorized modification or deletion.
- Efficiency and Speed - Users prefer a fast, responsive platform that minimizes manual searching and document handling.
- Automation of Tasks - Automatic generation of QR codes for each uploaded project facilitates easier referencing during defenses.
- Data Consistency - Administrators require a system that reduces redundancy and maintains standardized records.
- These identified needs became the basis for defining the system's architecture, interface design, and functionality.

HARDWARE REQUIREMENTS	
	Desktop/Laptop - A laptop is a portable computer that you can use anywhere, while a desktop personal computer (PC) is a stationary computer that sits on a desk or table.
	Memory: 8 GB RAM - Provides temporary storage for active processes and applications, ensuring smooth system performance.

	Storage: 500 GB HDD/256 GB SSD - Stores system files, databases, and software. HDD offers larger capacity, while SSD provides faster loading and data access.
	Network Interface: Gigabit Ethernet - A component that enables a stable and high-speed internet connection for data transfer and web system access.
	Power Supply - 600W - Delivers sufficient power to the computer components for stable and consistent operation.

Table 1: Hardware Requirements

This table presents the hardware components required for the development and testing of Research Repository and Smart Asset Management System prototype including their description and functions. The setup includes a desktop or laptop computer as the primary workstation, equipped with at least 8 GB of RAM to ensure smooth performance during system operation. Storage components consist of a 500 GB HDD and a 256 GB SSD for storing files, databases, and applications. A gigabit Ethernet connection provides stable and high-speed network access, while a 19-inch monitor offers adequate display space for system design and testing. Additionally, a 600W power supply ensures stable and consistent operation of all hardware components. These specifications collectively provide the necessary performance and reliability for system development and execution.

SOFTWARE REQUIREMENTS	
	VSCODE - a source-code editor developed by Microsoft for Windows, Linux, macOS and web browsers.
	IntelliJ IDEA -an integrated development environment (IDE) developed by JetBrains that helps programmers write code more efficiently.
	Postman - a tool for testing and managing APIs.
	XAMPP (MySQL) - an open-source software package that creates a local web server for developers to test and build applications.
	Canva - create social media posts, videos, presentations, slides, posters, art, drawings and many other visual assets.

	Figma - a cloud-based, collaborative interface design and prototyping tool used for creating digital products like websites and mobile apps.

Table 2: Software Requirements

This presents the software requirements used in developing the Research Repository and Smart Asset Management System. Visual Studio Code and IntelliJ IDEA were utilized as development environments for writing and managing source code. Postman was used for testing and managing APIs, while XAMPP (MySQL) provided a local server environment for database operations. Canva and Figma were used for creating visual materials and interface designs, respectively. These software tools ensured efficient development, testing, and design of the system.

KNOWLEDGE REQUIREMENTS	
	HTML - Defines the structure and content of web pages, including text, forms, and multimedia elements.
	Javascript - A scripting language that adds interactivity and dynamic behavior to websites.
	CSS - Used to style and format web pages by controlling layout, colors, fonts, and visual presentation.

	Java (Springboot Framework) - A backend development framework used to build secure, scalable, and efficient server-side systems.
	Web Programming - The skills required to build, design, and maintain websites and web applications.
	API - A set of rules and protocols that allows different software applications to communicate and exchange data with each other.
	Canva - A design tool used for creating visual materials such as UI concepts, documentation graphics, and presentation assets.
	Figma - A cloud-based design and prototyping tool used by UX/UI designers to collaborate on and create digital products like websites and mobile apps.

Table 3: Knowledge Requirements

This table presents the knowledge requirements essential for the development of the proposed system. The project requires familiarity with HTML for structuring web content, CSS for styling and layout, and JavaScript for adding interactivity and dynamic behavior. Knowledge in Java (Spring Boot Framework) is necessary for developing secure and efficient backend systems, while understanding API integration enables effective communication between software components. Additionally, web programming skills are essential for designing and maintaining

functional websites. Canva and Figma are also utilized for creating visual designs and prototypes that enhance user interface and user experience. These knowledge areas collectively ensure the successful design, implementation, and presentation of the system.

SOFTWARE SPECIFICATIONS		
Application	**Description**	**Version**
VSCODE v1.105.1	VSCODE - a source-code editor developed by Microsoft for Windows, Linux, macOS and web browsers.	**v1.105.1**
Intelli IDEA v21.0.7	IntelliJ IDEA -an integrated development environment (IDE) developed by JetBrains that helps programmers write code more efficiently.	**v21.0.7**
Postman v11.68.5	Postman - a tool for testing and managing APIs.	**v11.68.5**
XAMPP v3.3.0	XAMPP (MySQL) - an open-source software package that creates a local web server for developers to test and build applications.	**v3.3.0**
Canva v1.117.1	Canva - create social media posts, videos, presentations, slides, posters, art, drawings and many other visual assets.	**v1.117.1**

Figma v125.4.9	Figma - a cloud-based, collaborative interface design and prototyping tool used for creating digital products like websites and mobile apps.	**v125.4.9**

Table 4: Software Specifications

This presents the software requirements used in developing the Research Repository and Smart Asset Management System. Visual Studio Code (v1.105.1) and IntelliJ IDEA (v21.0.7) were utilized as development environments for writing and managing source code. Postman (v11.68.5) was used for testing and managing APIs, while XAMPP (MySQL) (v3.3.0) provided a local server environment for database operations. Canva (v1.117.1) and Figma (v125.4.9) were used for creating visual materials and interface designs, respectively. These software tools ensured efficient development, testing, and design of the system.

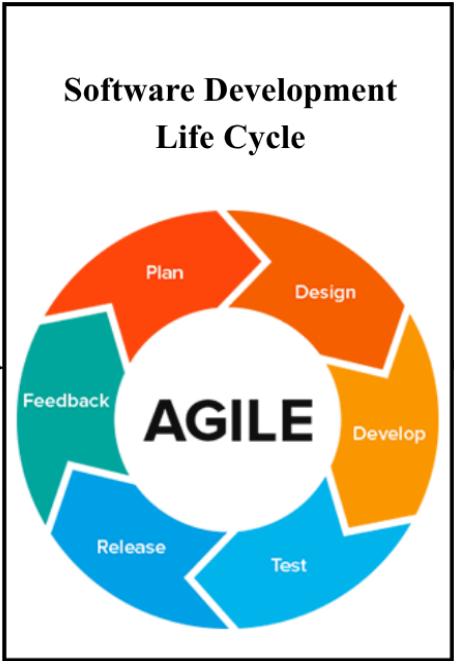| PROGRAM SPECIFICATIONS	
Program Specification	**Descriptions**
HTML	Defines the structure and content of web pages, including text, forms, and multimedia elements.
JAVASCRIPT	A scripting language that adds interactivity and dynamic behavior to websites.
CSS	Used to style and format web pages by controlling layout, colors, fonts, and visual presentation.

JAVA (Springboot Framework)	A backend development framework used to build secure, scalable, and efficient server-side systems.

Table 5: Program Specifications

Table 5 shows the program specifications and short description used for developing the prototype. The programming language used for developing the prototype are HTML, CSS, JAVASCRIPT, JAVA (Springboot Framework).

Software Process

In developing the Blockchain-Enabled Research Repository and Smart Asset Management System for the Research and Extension Department, we can use the Software Development Life Cycle (SDLC) as a guide to organize and manage each phase of the project.

Plan - In this phase, the research team identifies the needs and objectives of the Research Repository and Smart Asset Management System. This includes determining how blockchain can be used to secure research data, and improve transparency. The team also plans the system features, user roles, and timeline for each sprint to ensure the project meets academic and functional goals.

Design - The Design phase focuses on creating the system user interface. The team designs how the blockchain network will handle research repository transactions and asset management functions. It includes wireframes, database Structure, and flow diagrams to ensure the system is efficient and secure.

Develop - During this phase, the system is built and coded based on the prototype and flowchart. The database connections and Administrator interface are developed in small, iterative cycles. Features like uploading research documents and managing assets are gradually implemented and refined.

Test - The Test phase ensures that each function of the system works correctly and securely. The team conducts continuous testing to detect bugs, check blockchain transaction accuracy, and verify that research data cannot be altered or duplicated. Administrator testing may also be performed to evaluate system usability and performance.

Release - Once the system passes testing, it is deployed for use by the Research Repository and Smart Asset Management System. The release may begin with a pilot implementation to allow administrators to explore its features—such as uploading research outputs and tracking assets securely. Feedback during this stage helps ensure the system is stable and functional before full deployment.

Feedback - After deployment, feedback is collected from researchers, faculty, and staff to assess system efficiency, security, and ease of use. Suggestions are recorded to improve upcoming versions or add new features. This continuous feedback cycle ensures that the system evolves to better serve the department's

By following the Agile SDLC methodology, The Plan, Design, Develop, Test, Release, and Feedback is a project that promotes continuous improvement and adaptability. Each phase provides opportunities to evaluate progress, refine features, and strengthen system reliability. Through this process, the Blockchain-Enabled Research Repository and Smart Asset Management System ensures transparency, data security, and operational efficiency, ultimately supporting the Research and Extension Department in managing and safeguarding valuable academic resources.