FYP Detailed Project Plan

Blockchain-based Ebook Transaction System for Transparent Book Sales

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Abstract

The lack of transparent transactions in the current ebook transaction system provides an opportunity for fraud from ebook platforms that inflict loss of income on the authors. Blockchain technology and InterPlanetary File System (IPFS) are introduced to the proposed transaction system in this project to publicize all necessary transactions and records to the network so that authors and readers can monitor and verify the flow of funds to prevent fraud or missing income. Both typical transaction and subscription services with a pay-per-page model are adopted in the system which matches the current ebook transactions system. The whole system including blockchain, backend server, database, and mobile app development will be implemented and tested to show the idea of the system is implementable with Ethereum blockchain and IPFS. Finally, the characteristics of the system such as security will be analyzed in the project.

Content

1. Introduction

1.1. Background

Ebooks provide an alternative path for reading with the advantages of convenience, searchability, sale prices, and environmental friendliness (Staiger, 2012). The ebook market is experiencing rapid growth. According to Errera (2023), the number of eBook sales in the United States rose from 69 million to 191 million between 2010 and 2020. Moreover, it is estimated that there will be more than 1.2 billion ebook users in 2027 globally. The process of ebook transactions mainly involves three parties. Sellers, who can be authors and publishers, own their books and publish them on online ebook platforms. Platforms, such as Amazon Kindle Direct Publishing(KDP), Google Play Books, and Apple Books, provide software support for selling, purchasing, and reading ebooks. Buyers buy and read ebooks on ebook platforms.

In typical transaction services, buyers purchase the desired ebooks with the price for each ebook and receive the right to read the ebooks permanently. Besides, subscription services are proposed for ebook transactions (Polanka, 2013). Buyers can subscribe to the services monthly or yearly, and then freely access a large number of specified ebooks within the period of subscription. For example, Kindle Unlimited in KDP is one of the ebook subscription schemes that provides more than 4 million ebooks and allows subscribers to access 20 ebooks simultaneously (Chen, 2023). Huang et al. (2022) mentioned that subscription services produce a stable and long-term income for ebook platforms because they cultivate a group of subscribers who renew their subscriptions. Similar to the pay-per-play model for music streaming, the pay-per-page model is proposed to address the subscription services of ebooks. The subscription model is relatively fair and reliable compared with the one-time payment provided by the platform to invite the authors to join the subscription scheme since the sales quantity of ebooks is hard to predict accurately. One popular allocation strategy of income from subscriptions considers the total income of the services and the contribution of different books in order to distribute income fairly. Kindle Unlimited in KDP applies the pay-per-page model as the distribution strategy (Shannon, 2015). Kindle Edition Normalised Page Count (KENPC) is proposed to eliminate unexpected and unfair page counts due to the different fonts, line spacing, and margins.

1.2. Motivation

The general typical ebook transaction process is illustrated in Figure 1. After the author publishes an ebook on the platform and a reader buys the book, the royalties are remitted to the author. The statistics about the book such as the sales quantity can be obtained from the platform. However, it is difficult to verify the royalties because of the lack of transparency in the transaction and verifiable statistics. Authors are unable to access the transaction records between readers and the platform, thereby lacking a reliable and trustable method to ascertain the existence of any missing royalties or fraud from the platform. The transaction process for typical services without any sufficient supervision from third parties provides an opportunity for fraud led by the platform so that the platform gains extra profit. As a result, authors would experience an unfriendly transaction model with the risk of royalties loss (Nizamuddin et al., 2019).

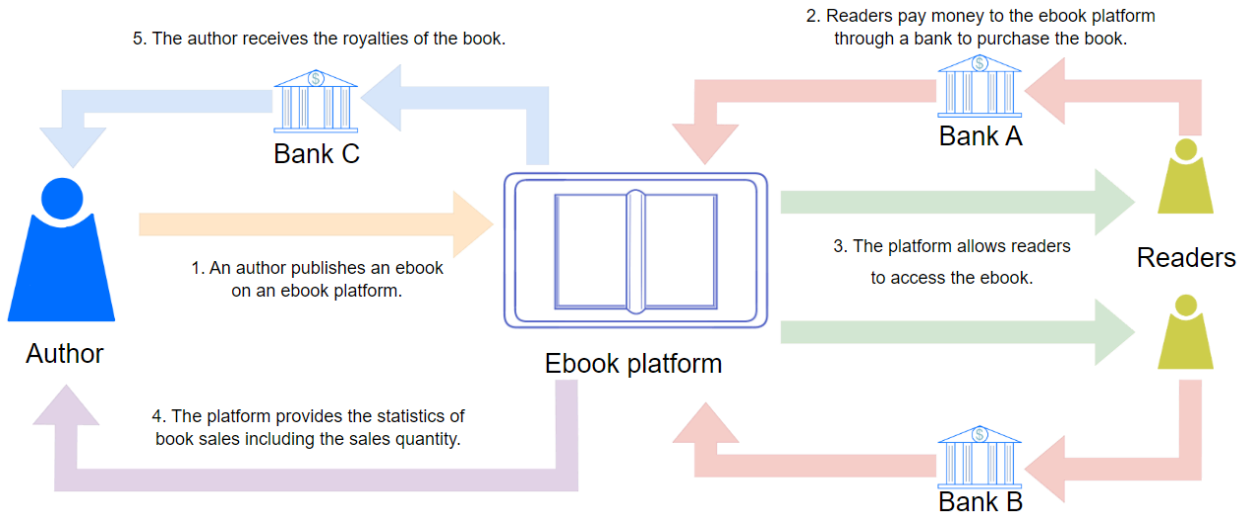

Fig. 1 The general typical ebook transaction process

In addition, the same problem also exists in ebook subscription services. For example, a simple equation is mentioned to calculate the royalties of each book (Jacobs, 2014):

$$The\ royalties\ of\ a\ book$$

$$= \frac{total\ amount\ of\ revenue\ earns\ from\ subscribers\ R}{total\ times\ of\ books\ read\ P_1} * total\ times\ of\ the\ book\ read\ P_2$$

Where R is the total amount of revenue earned from all subscribers in a period.

P_1 is the total reading times of all books in the period.
P_2 is the total reading times of the book in the period.

The distribution strategy is similar to that of the pay-per-pages model but uses books as the unit instead of pages. The platforms do not have technological restrictions on reporting a lower number of subscribers and the total amount of revenue than the actual values such that more profit can be gained. The income that cannot be validated may become a factor that discourages authors from issuing their books on platforms as well as further detrimental to the ebook market.

1.3. Proposed Solution

In the project, blockchain technology is proposed to provide a reliable and trustable verification method without trusting other parties. All transaction records are stored in the blockchain and all nodes of a network contain a copy of the blockchain so that the people in the network can view the transparent transactions. Furthermore, some critical characteristics of blockchain ensure a transparent ebook transaction system can be designed using the technology of blockchain (Chi et al., 2020):

- **Decentralization**: All transaction records are stored in the nodes of the network instead of a central server only. It prevents a part of nodes hidden some of the transactions.
- **Immutability**: Once a block of transactions is added to the blockchain, it is almost impossible to modify the content of the block.
- **Transparency**: All people in the network can access the transactions of the blockchain.
- **Security**: Blockchain contains asymmetric cryptography and allows digital signatures for authorization to prevent any unauthorized and fraudulent transactions. Only the owner who has the private key can sign a transaction. The public key generated by the private key is public for verification, but the private key cannot be generated by the public key.
- **Verifiability**: Consensus mechanisms of blockchain provide algorithms to validate transactions and blocks to intercept invalid data. Everyone can use the public key to verify the signature of transactions. The balance of the public key can be calculated as all transaction records are transparent.

- **Smart Contracts**: Self-executing contracts can be implemented and enforced automatically based on blockchain technology. It is useful to control the money flow of the ebook transaction.

All transactions and distributions involved in the suggested ebook transaction system are public in the blockchain. The movement of funds will happen only on the blockchain platform. Therefore, besides cryptocurrencies of the blockchain platform, other currencies are absent in the proposed model. Smart Contracts would be designed to handle a part of the process of transactions. The credibility of the system would be enhanced from the perspective of authors and readers as more details of the transaction can be verified such as the total revenue and the distribution ratio of the platform and different authors in subscription services.

1.4. Objectives and Deliverables

In this project, a transparent ebook transaction system will be constructed with the integration of blockchain technology. The deliverables involved blockchain technology, mobile application development, and backend development. The system supports both typical transactions and subscription transactions to fit the requirements of the current ebook sale model. The essential information about transactions and contracts is transparent on the network in order to address the issue. The reliability of the system will be analyzed, and the restrictions on illegal behaviors from different parties will be illustrated. Also, the system including smart contracts for the blockchain application platform Ethereum will be implemented using Solidity in this project. The blockchain-related part of the deliverables will be tested and analyzed to show that the idea is secure and reliable. A backend server for an ebook platform and an Andriod mobile application for readers and authors are the remaining parts of the implementation. The platform server contains the database which stores the data to respond to the service of the mobile app. It is also designed to handle communication with the Ethereum blockchain and the InterPlanetary File System (IPFS) including deploying transactions, ebooks and subscription information, as well as interacting with smart contracts. The mobile app provides functions that support viewing, purchasing, reading, refunding, and subscribing to ebooks for readers, and also authors to publish their books and view the statistics.

The remaining sections of this project plan are outlined as follows. In Section 2, the related work is mentioned to provide a review of current research relevant to the project topic. Section 3

shows the structures of the system design and each component of the system. The project planning and the summary of the project plan are in sections 4 and 5 respectively.

2. Literature Review

Chi et al. (2020) proposed a secure blockchain-based ebook transaction system with high reliability. Elliptic curve cryptography as one of the asymmetric cryptography is used in the system to ensure the security of the system. Ebooks information and transactions on the blockchain are immutable so readers and authors can trust the transactions. The research also claimed that the transactions happen between authors and readers directly through the blockchain so intermediate costs do not be produced by ebook platforms. However, excluding the blockchain, authors, and readers, a service application assumed to be trusted and a repository for storing encrypted ebooks are required for self-published ebook transactions (Chi et al., 2020). Therefore, extra costs may be produced to maintain the services.

Nizamuddin et al. (2019) also proposed a blockchain-based framework for ebook transaction systems to guarantee authors receive expected royalties based on smart contracts. The framework handles the refund if the transaction fails in the middle of the process. They completed the implementation of the smart contracts using Remix IDE with the programming language Solidity. It was tested and analyzed against recognized attacks and vulnerabilities. Moreover, It is noted that both two systems are designed for typical ebook transactions but not subscription ebook transactions.

Although there is a lack of research related to subscription ebook systems with blockchain, a blockchain-based system has been designed for the pay-per-play subscription model of music streaming (Chavan et al., 2019). When users play the music, a fixed amount of tokens from a pool is given to the artist. It also supports further distribution by smart contracts. They also stated that a fixed percentage of tokens will be put into the pool when a block is mined. However, the details of the mechanism for preventing the situation of no tokens in the pool were not mentioned. Furthermore, the idea does not address the problem of an artist playing the role of a user and playing their music repeatedly in order to extort tokens from the pool.

Heavy documents can be stored in the decentralized storage system, InterPlanetary File System (IPFS) instead of the blockchain because it is costly to store the data in the blockchain

(Nizamuddin et al., 2019). The file in the IPFS is also immutable as the file is stored in the decentralized network and can be located by the hash of the file as the content identifier (CID). It provides a faster and cheaper method to store and access files compared with blockchain technology and still contains the properties of immutable and public access (Sarode & Bhalla, 2022).

3. Methodology

3.1. Revenue Distribution for the Proposed System

The blockchain-based ebook transaction system is provided to handle ebook purchases and subscriptions. Readers can use cryptocurrency to pay the book price set by the author for purchasing the book if they want. A part of the cryptocurrency will be given to the platform as a tax income and the rest of the cryptocurrency will be given to the author as royalties.

The ebook platform may also want to provide ebook subscription services to attract readers and create income (Hsiao and Chen, 2017). In the system, a possible pay-per-page model is used in the design and implementation of the subscription service. Readers can subscribe monthly to the plan provided by the platform and have permission to read the books that join the plan. The subscription plan needs to be fair for authors so that they will consider joining the plan with their book. The revenue distribution in the system is described with the following equations.

$$income\ gained\ of\ the\ platform = total\ revenue * tax\ rate$$

The platform can set the tax rate in the range of 0% to 100% to gain a percentage of the total income. Total revenue is the total monthly revenue received from all subscribers. For example, if there is 100,000 Kwei revenue belonging to a month and the tax rate is 20%, then the platform will gain 20,000 Kwei where Kwei is a unit of the cryptocurrency of Ethereum. The rest of the revenue will be distributed to authors using a pay-per-page model.

$$author's\ income\ from\ a\ book$$

$$= \frac{total\ revenue * (1 - tax\ rate)}{total\ pages\ read\ of\ the\ book} * total\ pages\ read\ of\ all\ books$$

The above pay-per-page equation is used to calculate the profit of a book in a month. The remaining revenue will divided by the number of total pages read from all readers for all books to calculate the profit gained from every page read. If 80,000 Kwei remains for authors, a total of 10 million pages of all books read, and a total of 1,000 pages of a book was read from different readers in a month, then the author earns 1000*80000/10,000,000=8 Kwei.

Since authors and readers can join the subscription service of the system at any time of the month, to ensure the revenue is distributed fairly to the corresponding books, the accumulation of the page counts is reset with settlement later when a new month starts. In addition, the income of a single payment may need to be assigned to different monthly revenue amounts. In other words, the idea aims to decrease the error of the ratio between the contribution and profit of books caused by the gap of the factors of the above equation in different months. This idea affects the implementation of smart contracts and the structure of the reading record of the subscribers.

3.2. System Structure

The system involves the communication between the mobile app, backend server, IPFS, and Ethereum blockchain. The major data flows between entities are shown in Figure 2. A backend server will be developed to hold data in the database and interact with the IPFS, the blockchain, and the app. All necessary functions for readers and authors are provided through the app. They can also access the data of the IPFS and the blockchain to complete the validation. The data for validation do not pass over to the backend server of the mobile app so that the online bookstore is impossible to modify the data to defraud the readers and authors.

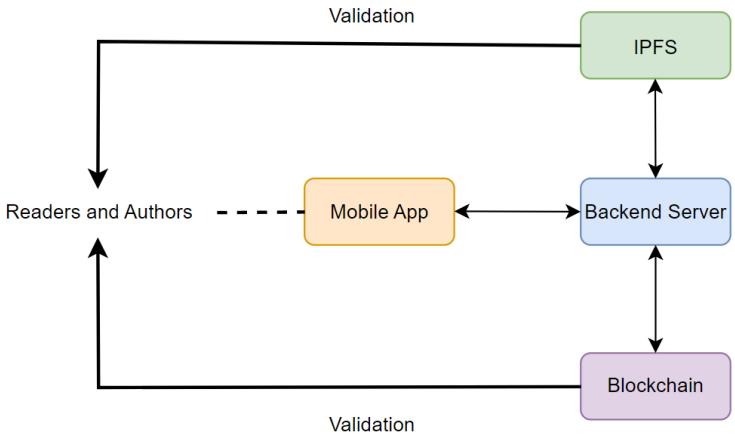

Fig. 2 Data flows of the system

3.3. Process Overview

The proposed procedures for ebook transactions and subscriptions to solve the problem are described in the section. The idea of the smart contracts is implementable using Solidity and works on the Ethereum blockchain. The typical transaction process is shown below:

1. Smart contract deployment

A smart contract is deployed by the system that allows the buyers to call the function in the smart contract and transfer the money to the smart contract. The money is stored in the smart contract temporarily so that a refund is possible before distribution.

2. Submission of a book to the server

When an author wants to publish a book to the platform server, the author needs to log in to the mobile app and submit the book title, book content, book price, and the address of the Ethereum account of the author to receive royalties. The address of a private key can be generated by its public key.

3. Ebook available in mobile app

If the platform accepts the application, the book is available on the bookstore in the app with a unique book ID generated using the book title. A pair of the book ID and the author's address are also deployed to IFPS. Both the address for receiving the royalty and the book title are not allowed to be changed such that the buyers are able to confirm the money goes toward the

correct address before signing the transaction. The book's information including the book title, book preview, book price, and book ID, is public on the bookstore.

4. Ebook purchasing

If the readers click the button to purchase the book, they receive a transaction preview from the platform server. The preview for Ethereum blockchain transaction contains the following elements:

Sender Address: The address of the reader account.

Recipient Address: The address of the smart contract to which the transaction is being sent.

Value: The price of the book. The amount of cryptocurrency is sent to the smart contract.

Data: The name of the function that transfers the money to the contract is called. The due date of the transaction is also passed to the function as a parameter so that the contract can reject the expired transaction. The book ID, the user ID, and the signature of the transaction signed by the platform are included in this transaction.

Gas Limit: The maximum amount of gas that can be consumed by the transaction.

Gas Price: The price the sender is willing to pay per unit of gas to execute the transaction.

Nonce: A unique number used to prevent replay attacks and to order transactions from the same sender.

Signature: The cryptographic signature of the sender to authorize and authenticate the transaction.

After a reader signs the preview using their private key, it indicates the agreement of the reader to buy the ebook. The platform deploys the transaction and checks continuously if the transaction is deployed on a new block. Once a valid call of the smart contract is packed in the new block, it means that the call of function is executed in the blockchain. The system checks the result of the execution and gives permission to access the book to the account of the reader if successful.

5. Income distribution

The smart contract deployed in the first step also provides an other function which can be called by the platform system to assign the money of the smart contract to the addresses of the platform and authors.

The subscription process is similar to the typical transaction but it contains some variations. Another smart contract is constructed for subscriptions. The author can simply apply for adding the book to the subscription plan through the mobile app. The book price is not required in the application of joining the plan with the ebook as the price of the plan is set by the platform. After a subscriber signs the preview, the system checks the result of the execution and gives permission to access the books that joined the plat if successful. In the final step, the reading record of each subscriber will also be uploaded to IPFS monthly.

3.4. Mobile App Development

The app helps readers to read ebooks on their phones conveniently. Authors can manage their ebooks on the app. Excluding the validation of the money flow of the smart contracts, readers and authors only need to interact with the app to enjoy the services. The functions provided by the app are shown in the following table:

Functions	Description
Login System	Users can log in to the mobile app using their email and password.
Bookstore	Readers can browse, search, purchase, and subscribe to books in the bookstore. The search function supports text, publish date, and book type filters to help users find specific books easily.
Personal Bookshelf	Readers can access their bookshelf to view purchased and recently read books.
Publish Ebook	Authors can publish their books by uploading them with the required information to the platform, making them available for purchase.
Subscription Services	Readers can subscribe to a monthly plan that grants them access to

for Readers	the books that join the plan.
Reading Activity Tracker	Subscribers can view the detailed records of their reading activity, including the total pages read for each book monthly.
Enroll in Subscription Services	Authors can apply to include their books in the subscription plan, expanding their reach to a broader audience.
Transactions signature	Readers can sign the blockchain transaction generated by the server. The server deploys the authorized transaction for readers.
Authors' Analytics Dashboard	Authors have access to an analytics dashboard where they can view detailed statistics of their ebooks, including sales and revenue generated.

3.5. Backend Database and Server

The following tables (Figure 3) show the attributes of different entities that are included in the database. Those data help the server complete different tasks in order to provide services. The details of them such as relationships and data types, are planned to be finished later in the period of the project. In addition, more entities and attributes may be appended to the database to provide all expected functions with fast responses.

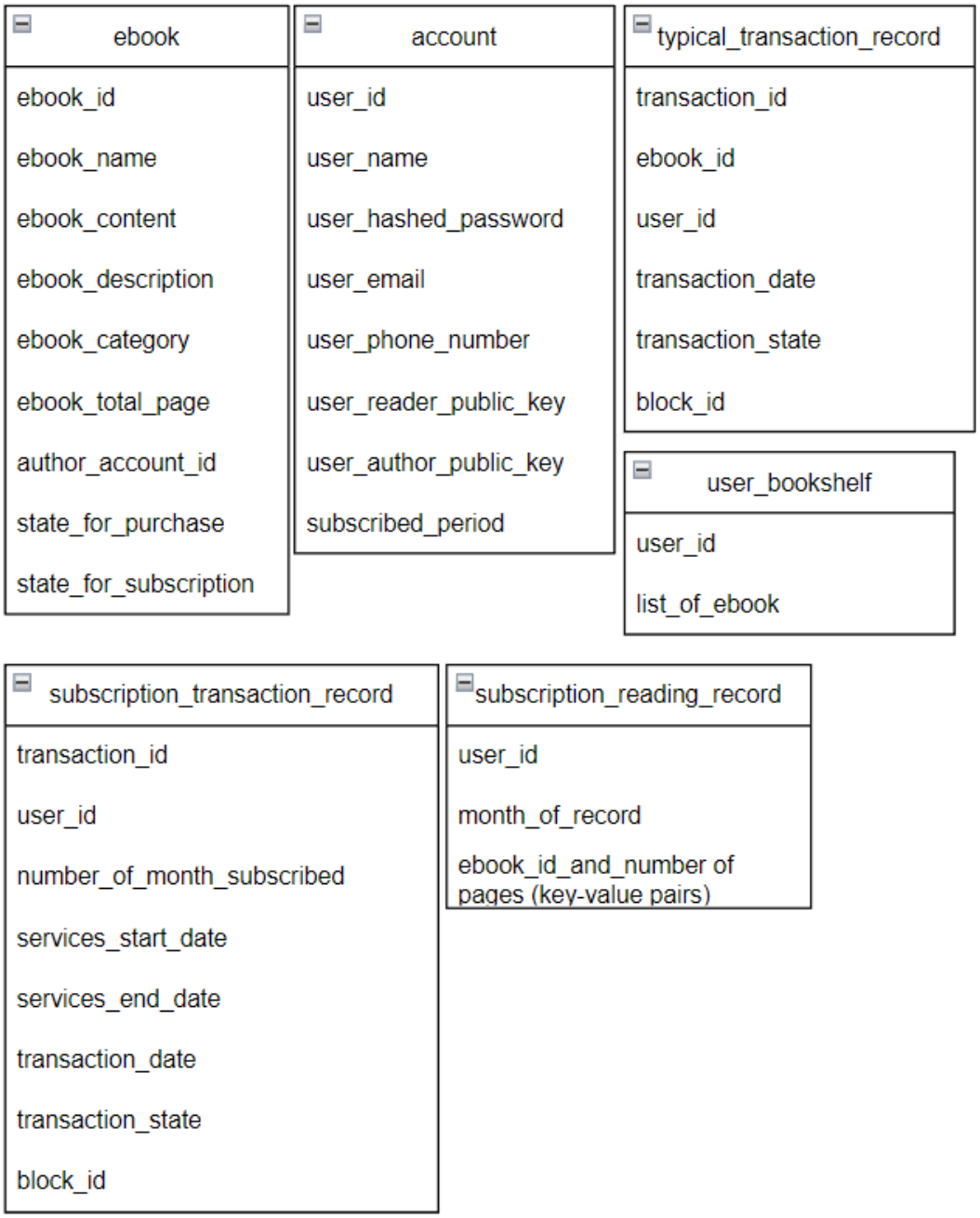

Fig. 3 The attributes of different entities in the database

A relational database management system MariaDB is planned to be used to develop the database for the system as it is suitable to store the data of the above entities and represent the relationship. It also provides a better performance with high availability, and scalability, and is compatible with MySQL.

The backend server is needed to receive the requests of the mobile app and respond based on the data of the database. Moreover, the server keeps tracing the new block of the Ethereum blockchain to determine the related valid transactions that are deployed. The server also takes the role of deploying all smart contracts, transactions, and documents to the blockchain and IPFS. Programming language with JavaScript with Node.js will be used to develop the server.

4. Project Schedule

The overview of the schedule of the project is shown in Figure 4. The grids in the table are roughly represent 7-8 days in each month. A part of the initiation of the project, such as the project background and literature review, has been finished in order to create a comprehensive project plan and be ready for implementation. The major part of the implementation is planned to be completed before the interim report. Finally, all components of the project including testing and analysis are scheduled to be finished before the submission of the final phase.

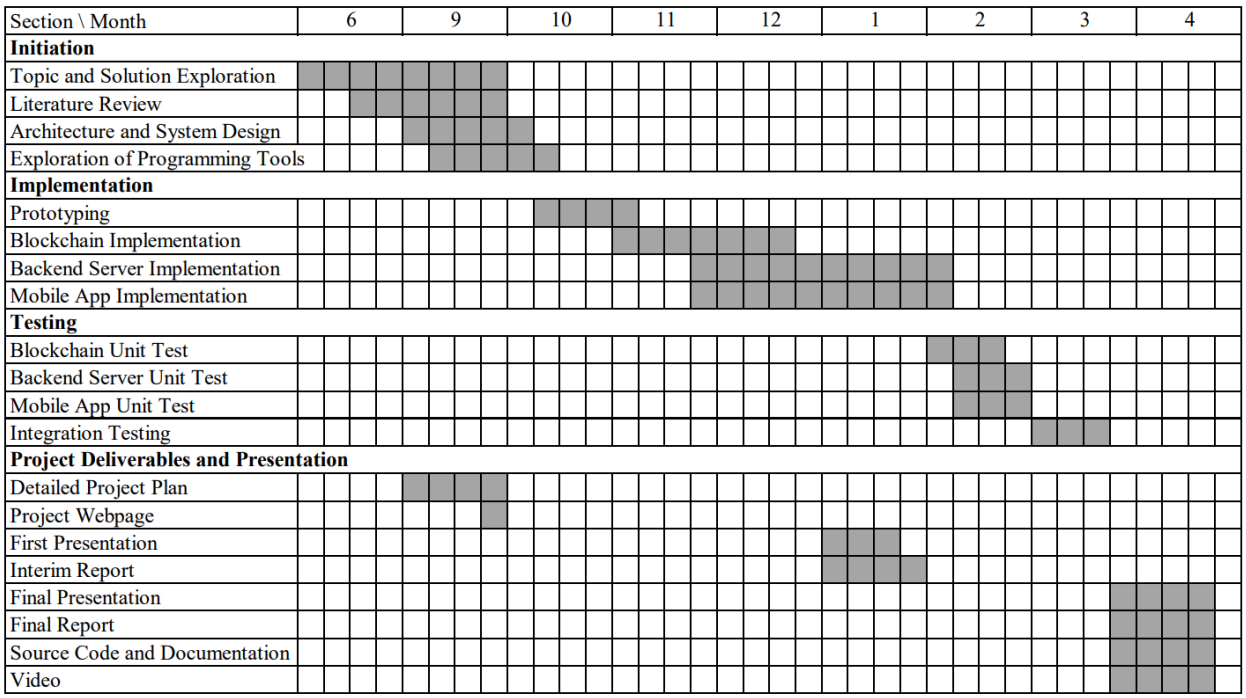

Fig. 4 The schedule of the project

5. Conclusion

In the project plan, the description objective and deliverables were covered. The project aims to design and implement a transparent transaction system with blockchain technology for the current ebook sales. The proposed system enhances the credibility of ebook transactions as they can be verified through a reliable method. The system will be implemented and tested in the project later to show that it is feasible. Certain important ideas were mentioned in the project plan that related to the system structure and implementation, such as the distribution strategy for the ebook subscription scheme and the functions of the system components. Lastly, the tentative schedule has been designed to show the timeline of each task.

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