

BookNest: A Peer-to-Peer Book Sharing Platform

By

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FINAL YEAR DESIGN PROJECT REPORT

This Report Presented in Partial Fulfillment of the
Requirements for the **Degree of Bachelor of Science in
Computer Science and Engineering**

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APPROVAL

This Project titled "**BookNest: A Peer-to-Peer Book Sharing Platform**" submitted by **Md Rakib Hassan** to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on **16-09-2025**.

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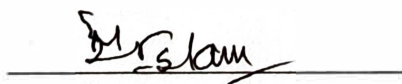
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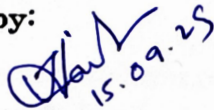
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We hereby declare that this project has been done by us under the supervision of **Dr. Sheak Rashed Haider Noori, Professor & Head**, Department of Computer Science and Engineering, Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for the award of any degree or diploma.

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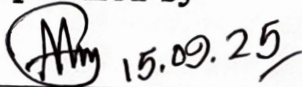

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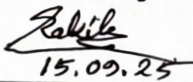

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ABSTRACT

Accessible and affordable reading resources is also an issue among many communities where costly books and the unavailability of books limit accessibility especially when it comes to learning and the spread of knowledge. To curb this vice, BookNest has been realized as the MERN stack based website where hardcover book sharing among people is promoted as a community effort. The workflow starts with the secure user authentication and is based on the role-based access, delivering secure and trusted interactions. Users can also add books to the site, upload cover picture with details and later share it with other users through lending, purchasing or selling. A borrower may request for a book right through the system, in which case an request is created in the backend where it is tracked until it is given to the borrower. To better facilitate accessibility BookNest uses distance-based filtering to help those find books close to them, and includes a view of the physical location of these books as an embedded map before taking them out. These closely related modules, on the request fulfillment, geolocation and authentication as well as book management, search and discovery, are backed by a modular architecture that divides models, controllers, services and routes. This architecture is scalable, maintainable, and provides efficient data flow of all the components. The integration of a pragmatic borrowing process with smart search and location-based capabilities is an intuitively recognizable and sustainable product that will reduce economic obstacles, and foster a culture of books sharing.

Table of Contents

Approval	i
Declaration	ii
Acknowledgements	iii
Abstract	iv
List of Figures	vii
List of Tables	viii
1 Introduction	1-4
1.1 Introduction.....	1
1.2 Motivation	2
1.3 Objectives	2
1.4 Methodology.....	3
1.5 Project Outcome.....	3
1.6 Organization of the Report.....	4
2 Background	5-14
2.1 Introduction.....	5
2.2 Literature Review.....	6
2.2.1 Similar Applications.....	11
2.3 Gap Analysis	13
2.4 Summary	14
3 Research Methodology	15-36
3.1 Requirement Analysis & Design Specification.....	15
3.1.1 Overview	15
3.1.2 System Design	16
3.1.3 Functional and Nonfunctional Requirements.....	17
3.1.4 Data Flow Diagram	19

3.1.5	Sequence Diagram.....	20
3.1.6	Entity-Relationship (ER) Diagram.....	21
3.1.7	UI Design	24
3.2	Detailed Methodology and Design	33
3.3	Project Plan	35
3.4	Task Allocation.....	36
3.5	Summary	36
4	Implementation and Results	38-40
4.1	Environment Setup	38
4.2	Testing and Evaluation.....	38
4.3	Results and Discussion.....	39
4.4	Summary	40
5	Engineering Standards and Design Challenges	41-49
5.1	Compliance with the Standards	41
5.1.1	Software Standards	41
5.1.2	Hardware Standards.....	42
5.1.3	Communication Standards.....	42
5.2	Impact on Society, Environment and Sustainability	42
5.2.1	Impact on Life	42
5.2.2	Impact on Society & Environment.....	43
5.2.3	Ethical Aspects.....	43
5.2.4	Sustainability Plan.....	43
5.3	Project Management and Financial Analysis.....	43
5.4	Complex Engineering Problem	45
5.4.1	Complex Problem Solving.....	45
5.4.2	Engineering Activities	48
5.5	Summary	49
6	Conclusion	50
6.1	Summary	50
6.2	Limitation	50
6.3	Future Work	50
	References	52

List of Figures

3.1	BookNest System Architecture Diagram.....	17
3.2	Data Flow Diagram of BookNest.....	20
3.3	Book Sharing Sequence Diagram in BookNest	22
3.4	Entity-Relationship Diagram of BookNest.....	23
3.5	Lending page of BookNest	25
3.6	Add Book page of BookNest	26
3.7	Pickup Point page of BookNest	27
3.8	My Books page of user in BookNest	27
3.9	My Request page of BookNest	28
3.10	Manage Request page of BookNest	28
3.11	Wallet page of BookNest	29
3.12	Borrow request Confirmation popup with note.....	30
3.13	Waiting for book owner decision.....	30
3.14	Payment from requester and otp verified from owner side	31
3.15	Security deposit claim by book owner	31
3.16	Manage user by admin.....	32
3.17	Manage Book by Admin	32
3.18	Transaction Monitoring by Admin	33

List of Tables

2.1	Summary of Literature Reviewed.	6
2.3	Gap Analysis of Existing vs Proposed System.	13
3.1	Task Allocation.	36
4.1	Test Cases and Results.	38
5.1	Project Cost and Financial Analysis.	44
5.2	Mapping with complex problem solving	46
5.3	Mapping with knowledge Profile.....	47
5.4	Mapping with complex engineering activities.....	48

Chapter 1

Introduction

This chapter is an overview of the BookNest project, covering some background on the motivation and background behind the project's development, the goals of the project, the methods used for the research, the expected results, and the general scheme of the report. It serves as the basis for understanding the limits and importance of the project.

1.1 Introduction

BookNest is an online book sharing platform designed to make hard copies of books cheaper and available to the readers of Bangladesh. The origin of the BookNest concept was related to the observation of the high price of books and the absence of community approaches that could assist in solving a problem. Most online stores in Bangladesh are new books only hence most readers find it hard to procure reading materials on a regular basis. This also implies that one has limited choices of trying to establish a community in which it is possible to share and sale used books.

BookNest is a low-cost, collaborative model that allows addressing this problem by forming a convenient alternative to the standard book selling processes. The site enables one to rent, trade and purchase new and used books. This network works as a peer to peer system with the aim of making the users enjoy their reading fully. Aiming to be as simple to use as possible, the primary objective of BookNest is not only assisting people to share their books but also providing the audience with quite intelligent recommendations driven by artificial intelligence that fits the interests of the audience.

The intended users of the project are the students, casual readers, and online book lovers seeking an effective way to access numerous books without incurring high spending on them. Dedicated to the ideas of affordability and the community, BookNest hopes to create an atmospheric reading culture in Bangladesh. It has the desire of uniting various readers with diverse backgrounds and letting them bond together because of their love of books.

Essentially speaking, BookNest is more than purchasing books and selling them, it is about developing a network of readers who are capable of supporting one another. The social network promotes people to write down their own most liked stories and suggestions, thus, establishing a vibrant environment, where everybody can spread. With fewer people needing to go to the stores themselves to get access to the books they enjoy, there is a potential of more people in Bangladesh exploring the world of

reading and sharing books with others.

1.2 Motivation

The main driving factor behind the production of BookNest is through the critical examination of the current market of Bangladesh within the environment of literature. One of the major challenges that students, those who read here and there, bibliophiles have to face is the exorbitant price of new books which serves as a great deterrence towards the process of knowledge gaining and leisure reading. To make it even worse, there is also the notable lack of an effective digital mechanism that specifically targets the community on how to manage the circulation of used books. Although there are many online stores to buy new publications, they fail to meet public needs in terms of getting cheaper yet efficient alternatives or the possibility of a circular economy of books.

This is a challenge and an opportunity in the form of this market gap. The weak point is the necessity to surpass negative tendencies in the e-commerce industry of Bangladesh where consumers lack online platform trust, payment systems are complicated, and online connection is quite expensive.[1] When conducting a study of e-commerce in Bangladesh, it was found that 82.5 percent of the respondents were worried about the reliability of online platforms and 60 percent of them had already experienced fraudulent activities, indicating the significant extent to which potential users are skeptic about any new platform.[1]

The idea behind starting BookNest was the belief that these problems can be solved with the help of careful design. The P2P model applied on the platform tackles the economic barrier of the high price directly as it allows users to earn money on books that they have already purchased as well as to buy the new reading contents at a much lower price than the retail one. At the same time, its community-integrated functionalities, e.g., visibility of user rating and administrative supervision, aim at fostering institutional trust in order to make a P2P ecosystem successful. So BookNest is not simply a business venture but it is rather a strategic intervention that has been exercised to utilize technology to eliminate certain types of socio-economic tensions that are currently subjecting the development of a general reading culture, i.e. in Bangladesh..

1.3 Objectives

The BookNest project will aim to maintain a complete software requirements specification of a web-based application that will mediate the lending, purchasing and selling of hardcover books. The essence of it will be to help make more books available and affordable to readers by using a pacesetter-to-peer open sharing mechanism. The platform is meant to provide a comprehensive ecosystem to book lovers in Bangladesh and hence the scope of the platform is also wide including the

following functionalities:

- i. Rental of hardcover books.
- ii. Sale and purchase of the new and second-hand books on a local/international scale.
- iii. Distance based filtering.
- iv. A book-review system.
- v. Possibilities of advanced sorting and filtering.
- vi. Specific dashboards of administrators and users.

1.4 Methodology

The methodology of the BookNest project was carried out in a well-defined process initiated with requirement analysis aiming at identifying both functional requirements including the book lending and borrowing, search, filter and user authentication and also non-functional requirements like security, scalability and usability. Based on these results, system architecture, database schema and user interface were designed in order to achieve a simple and efficient user experience. The base engine was built using Node.js [2], Express.js [3], and MongoDB [4], and the frontend was built using React [5] and Tailwind CSS [6] which integrates functionality such as the role-based authentication, request handling and pickup point selection. Rigorous testing was done including unit, integration and usability testing to check the correctness and performance of the system. Finally, the platform was moved to a scalable cloud environment that could be continuously monitored and iteratively improved according to user feedback in order to improve reliability and functionality.

1.5 Project Outcome

The result of the project should be the deployment of a full-stack Web application known as BookNest. The frontend and backend functionality and applications will use Vercel as a hosting platform due to its serverless nature and the database will be hosted using MongoDB [4] as its structure or design.

On completion the platform will be used by three different categories of users:

- i. Guests: Unregistered side users that could browse and search books but are not able to conduct any transaction or undertake any social activity unless they create an account.
- ii. Registered Users: Authenticated users having full access to all the P2P features (lending, buying, selling, reviewing and access to their personal dashboard and book collection).
- iii. Administrators: Privileged users who take care of the general management of the site including the user accounts, book listing, order processing and content

filtering.

The end product will be a one-of-a-kind value proposition in the Bangladeshi market, a product that will merge the cost-effective nature of the sharing economy with the interactive sense of online community building and the personalization that offers by use of artificial intelligence.

1.6 Organization of the Report

To give a clear and orderly analysis in this report, a total of six chapters are organized in this report. Chapter -1: Introduction ground rests the project in the context, motivation, purpose, and anticipated deliverable results. Chapter 2: Background offers detailed literature review on the related areas, review comparable applications and conducts a gap analysis to place the BookNest in the present market and academic environment. Chapter 3: Research Methodology and System Design describes the technical process, that is, the system architecture, functional and non-functional requirements, detailed design models Class, ER, and Sequence diagrams. Chapter 4: Implementation and Results describes the development environment, the plan of testing and evaluation and puts forward the expectations of the performance and usability outcomes. Chapter 5: Engineering Standards and Design Challenges compares the project to the body of professionally accepted standards, examines its effect upon the whole of society, and breaks down such knotty engineering issues that it solves, the cold-start problem or the challenge of P2P trust management. Chapter 6: Conclusion summarises the report, points to the existing limitations of the project and suggests specific and research-supported directions of future improvements.

Chapter 2

Background

This chapter provides the background of BookNest project focusing on the issue of book accessibility in Bangladesh to share readers with challenges of information access in a monitored context in the region, summarizes the existing literature and similar platforms and points out what gaps in terms of book accessibility are addressed by BookNest. It sets the academic and market context needed for justification of the project's development.

2.1 Introduction

In Bangladesh, access to physical books is usually restricted due to the factors of affordability, availability, geographic range. Even though there is still high demand of books especially among students and young adults, conventional methods of fulfilling book demands such as libraries and book shops have failed to satisfy the needs of the masses.

Statista [1] found that:

It is anticipated that the physical books markets in Bangladesh will produce more than US\$168.3 million in the year 2025, and, that the anticipated annual growth trend would be at 3.99 percent and approximately US\$196.8 million by 2029.

Total book market (digital and physical) volume is predicted to increase to US\$210.9 million in 2025, and the total amount of readers will exceed the mark of 38.8 million by the year 2029.

With this huge market, there is still a problem with the accessibility of the books. According to The Daily Star (2023), the sales of books decreased by 15 to 35 percent as compared to the previous years as a result of inflation and increased printing costs. This has led to the books being more expensive particularly to students and low income people.

The largest book fair held annually in the country, Amar Ekushey Book Fair 2024 resulted in a total of around 6 million visitors with sales of Tk 60 crore (\approx US\$5.6 million) in books.

Cultural interest in books is thus very strong, although it underscores the fact that access tends to be event-driven and geographically constrained to a few cities such as Dhaka.

Rokomari[7], a book web site launched in 2012, sells, but does not support lending or reselling of books. Secondly, second-hand book hubs such as Nilkhet Book Market

are localized and largely offline which the remote users are left out. Such international sites as Amazon [8] remain unavailable because of shipping expenses or are not adjusted to the Bangladesh environment.

These figures and trends together indicate an obvious missing element in the Bangladeshi book system. BookNest fills this vacancy with a digitalized approach to book rental and resale and none of the subscriptions or hidden costs. This qualifies BookNest as a comprehensive, low-cost and environmentally viable option to book lovers in the country.

2.2 Literature Review

The topical literature review presented below shows that there is a valuable world of platform options and studies that led to the design of BookNest. This review will be organized in the form of first analyzing similar applications available in the market followed by ultimately highlighting some of the academic findings that are pertinent in the main components of the project.

Literature reviewed summary

A review of major papers by scholars was performed in order to provide scholarly background of the project. Table 2.1 below will summarize and present the most relevant studies, their methodologies, and findings that are in the direct relation to how the system will be designed and analyzed BookNest.

Table 2.1: Summary of Literature Reviewed.

Author (s)	Year	Title	Methodology	Key Findings
Liu, X.[9]	2021	Research on University Book Sharing Cloud Platform	Research on university book sharing cloud platform	Discussed the design and implementation of a university-based book sharing platform, focusing on cloud integration and user accessibility.
Grüner, A. [10]	2024	Sharing is caring? The effect of negative peer-to-peer experiences on platform loyalty	Empirical study on user experiences	Found that negative peer-to-peer experiences lead to a decrease in loyalty intentions towards the sharing economy

				platform.
Schippers, A. L.[11]	2024	Sharing with minimal regulation? Evidence from the free exchange of books	Quantitative study on unregulated book sharing	Collected unique quantitative data on unregulated peer-to-peer in-kind exchange, highlighting the viability of free book exchange internationally.
Barlösius, E.[12]	2023	Data-Sharing in Peer-to-Peer Relationships	Analysis of data-sharing in peer-to-peer relationships	Identified three social forms of data-sharing in peer-to-peer relationships: closed communal sharing, closed associative sharing, and open associative sharing.
Wirtz, J.[13]	2019	Platforms in the peer-to-peer sharing economy	Conceptual analysis of P2P platform business models	Examined peer-to-peer sharing platform business models, their sources of competitive advantage, and the roles, motivations, and behaviors of key actors in their ecosystems.
Luo, C., & Chen, Y.[14]	2020	Design and Research of Private Book Sharing System Based on Sharing Economy Model	System design using RFID and CAN bus technology	Introduced a private book sharing system leveraging RFID and CAN bus technology to enhance resource sharing efficiency.
Schippers, A.L.[15]	2024	Sharing with Minimal Regulation? Evidence from Neighborhood Book Exchange	Quantitative data collection and analysis	Investigated the viability of unregulated peer-to-peer book exchanges through privately owned public

				bookcases, highlighting challenges like free riding behavior.
Sánchez-Pérez, M., et al.[16]	2020	Theoretical dilemmas, conceptual review and perspectives on P2P sharing	Conceptual review	Discusses challenges in P2P exchange, focusing on reciprocity, closeness, and participation.
Lampinen, A., et al.[17]	2021	The Trouble With Sharing	Book chapter	Explores challenges in P2P exchange, emphasizing reciprocity and participation.
Abbassi, A., et al.[18]	2009	Recommending Books to be Exchanged Online in the ReaditSwapit Community	Algorithmic analysis	Introduces an exchange algorithm maximizing matches between users' item and wish lists.
Huynh, T., et al.[19]	2023	Resistance to the sharing economy: Why some consumers resist sharing	Survey-based study	Identifies barriers hindering participation in the sharing economy, including trust issues and perceived risks.
Pera, M. S. [20]	2017	Recommending Books to be Exchanged Online in the ReaditSwapit Community	Algorithmic analysis	Proposes an exchange algorithm maximizing matches between users' item and wish lists.
Abhishek, V., et al. [21]	2021	Manufacturing Durable Goods in the Presence of Peer-to-Peer Sharing	Economic modeling	Analyzes the interaction between P2P rental markets and manufacturers of durable goods.
Bookverse C2C Team [22]	2024	BOOKVERSE C2C: Simplifying Book Exchange	Comparative analysis	Offers a user-centric design for peer-to-peer book exchange, addressing database optimization and device compatibility.

BookXchanger Team [23]	2024	BOOKEXCHANGE R: An IT-Driven Portal for Book Exchange	System development and chatbot integration	Highlights the importance of efficient chatbots in assisting users with book exchanges and purchases.
Sharebook App Team [24]	2025	SHAREBOOK APP: A Community-Based Book Sharing	App development and user feedback	Develops an Android-based platform facilitating physical book sharing within communities.
Book Loop Team [25]	2025	Book Loop: A Peer-to-Peer Book Exchange Platform	Platform development and community feedback	Creates a seamless and community-driven solution for book enthusiasts to share and exchange physical books.
Muhammad, M. [26]	2025	Develop a P2P Book Exchange Platform POC	Proof of Concept development	Demonstrates foundational features of a P2P book exchange platform with future enhancement potential.
Marth, S., et al. [27]	2022	Sharing on platforms: Reducing perceived risk for peer-to-peer exchanges	Experimental study	Investigates how trust-building measures can reduce perceived risks in P2P exchanges.
Yung, J. [28]	2018	Creating a book sharing platform from scratch	Case study	Provides insights into building a book sharing app, from design to implementation.
Strikingly Team [29]	2025	Top 5 Custom-Built Online Book Swapping Marketplaces	Market analysis	Reviews successful custom-built online book swapping platforms and their features.
Tejass Publishers [30]	2024	BOOKSWAP: Online Book Exchange System	System proposal	Proposes a platform for exchanging books online among

				students, focusing on ease of use and transaction management.
Lendstash Team [31]	2023	Lendstash: Peer-to-Peer Book Lending Marketplace	Platform development	Provides an integrated approach for local book lending and reselling.
Nguyen, P., et al. [32]	2022	Trust Management in P2P Sharing Systems	Simulation-based study	Shows the effect of reputation systems on increasing reliability in peer-to-peer book sharing networks.
V.M Salunke & More [33]	2025	Design and Development of a Digital Platform for Peer-to-Peer Book Exchange	Design and development of a digital platform	Proposed a comprehensive digital platform for book exchange, emphasizing user-friendly interface design and robust user verification and rating systems.

2.2.1 Similar Applications

To get a bigger picture of the scope and the uniqueness of BookNest it is worth looking at the available applications that offer services related to books. Some national and international platforms provide book discovery, cataloging, or sales but have no integrated peer-to-peer lending, location-based discovery, and structured borrowing tasks. The discussion of the ten most popular platforms includes their features, restrictions, and suitability to the Bangladesh users, and reveals how BookNest can fill the gaps in these platforms.

i. Goodreads [34]

Goodreads is a cross-border Internet site that provides assistance in locating books, reviewing and prerequisite analysis examinations, evaluations, and keeping up bibliographic reading lists. Although it is superb in community engagement and suggestions of the reading material, it does not enable lending, purchasing, or selling of physical books. Also, its supply chain and delivery framework cannot apply to Bangladesh since accessing the printed books is not easy. BookNest deals with this by incorporating the local lending and transactions of books which introduces the practical access to the Bangladesh users.

ii. Libib [35]

Users of the cataloging site can catalogue books, movies and music and share them in a limited community. It can be a personal digital library management tool and has limited sharing and acquiring functions, as well as no location-based search capability. Its infrastructure is mainly Western oriented, which makes it not applicable to Bangladesh. BookNest goes beyond this by adding in distance-based filtering and maps-based location of books, so that it is well suited to use within local communities as well.

iii. BookMooch [36]

BookMooch is a book-sharing service based on peer-to-peer that promotes circulation of books using a point system. It lacks structured order management, borrowing workflows or live tracking and might not be efficient. Moreover, its warehouse methodology does not reveal itself to be feasible in Bangladesh. BookNest removes this issue by offering formalised borrowing processes and transaction control, built to likeness of local users.

iv. LibraryThing [37]

LibraryThing is a site to catalog personal book collections and participate in online discussion. Although it has great organizational strength and social interaction, it is deficient in the physical access of the book feature and location. Neither has it been made in such a way that it can be used locally in Bangladesh. BookNest fills

this gap with a synthesis of the community, and real-world book circulation.

- v. **Litsy [38]**

Litsy is a social site that permits consumers to follow micro-analysis, quotations, and reading progress. It is interactive, and community-based but does not enable physical access to books, thereby, limiting its usability in practical terms. BookNest gives the opportunity to interact with other users, borrow/buy physical books locally.
- vi. **Storytel [39] (Bangladesh)**

Storytel is a service-providing platform in Bangladesh to provide audio books. It offers access to digital books without having the facility of lending, reselling, or physical books and only the one who loves digital books can use it. BookNest supplements it in the fact that BookNest emphasizes the physical circulation of books that is highly favored in Bangladesh.
- vii. **Rokomari [7] (Bangladesh)**

Rokomari is one of the most popular online book stores of Bangladesh. It will not have such functions as online purchasing and giving without a peer-to-peer loan system/community based sharing. BookNest can address this need by allowing users to lend, borrow and sell books within the locality to drive the sustainability of reuse.
- viii. **BoiMela [40] (Bangladesh)**

BoiMela is an online adventurous book outing sell and marketing in Bangladesh which is primarily aimed to sales during book fairs. It does not provide any structured workflows relating to borrowing, tracking transactions and social engagement. Such a combination is embodied by BookNest, where the integration of such features allows the maintenance of a constant cycle of circulation, supported by the community.
- ix. **MyLibraryBD [41] (Bangladesh)**

MyLibraryBD is a mini library management system that targets Bengali students. Although it permits the borrowing of signed-up libraries, it lacks peer-to-peer transfer and distance-discovery as well as map-based book referrals. BookNest overcomes these constraints both by offering local book discovery, geolocation, and by allowing direct user-to-user lending.
- x. **OpenLibrary [42]**

OpenLibrary is a worldwide service where one can get access to Electronic versions of books. Whereas it encourages access to reading all over the world, it does not encourage the lending of books, the purchase or the sale of books as a physical entity and does not localize its operations to the context of Bangladesh. Social

BookNest provides a face-to-face, neighborhood-based alternative that is localized to the readers.

2.3 Gap Analysis

Table 2.2 summarizes the features provided by existing book platforms and highlights the gaps that BookNest addresses.

Table 2.2: Gap Analysis of Existing vs Proposed System

Features	Goodreads	BookMooch	Rokomari (BD)	MyLibraryBD	Storytel (BD)	Proposed System
Physical book lending	No	Yes (but unstructured)	No	Limited	No	Yes
Peer-to-peer selling	No	Yes	No	No	No	Yes
Borrowing workflow & order management	No	No	No	No	No	Yes
Distance-based filtering	No	No	No	No	No	Yes
Map-based book location	No	No	No	No	No	Yes
User reviews & ratings	Yes	Yes	Yes	Limited	No	Yes
Advanced search & filtering	Yes	Limited	Yes	Yes	Yes	Yes
User authentication & role-based access	No	No	Yes	Limited	Yes	Yes
Social/book sharing features	Yes	Yes	No	Limited	No	Yes
Image/book cover upload	Yes	No	Yes	Limited	No	Yes
Multi-device responsive	Yes	No	Yes	No	Yes	Yes

2.4 Summary

This chapter provides background, literature review, similar applications and gap analysis to BookNest. It points out the problems faced in accessing physical books in Bangladesh as a result of affordability, absence of access, and geographic reasons although the country is facing a developing market and has a rich reading culture. The literature review looks into the scholarly research and already existing platforms and how e-commerce infrastructure and peer to peer models would inform the design of BookNest. The analysis of the global and local platforms Goodreads, BookMooch, LibraryThing, OpenLibrary, Rokomari, Storytel, BoiMela and MyLibraryBD shows that they have in common the absence of the physical book lending, of formalized borrowing and lending procedures, of distance filtering, and map-based search features of the locations of books. The gap analysis shows these weaknesses and explains how BookNest curtails them by providing a secure, community-centered environment that minimizes or eliminates all these hitches by including borrowing process flows, location-based services, social interaction, and cross-platform availability.

Chapter 3

Research Methodology

This chapter introduces research methodology and system design of the BookNest project. It provides the analysis of the requirements, functional and non-functional requirements, system architecture, data flow diagrams, UI design, and task allocation plan.

3.1 Requirement Analysis & Design Specification

The following section will be focused on the analysis of functional requirements of the BookNest application and will outline the specifications of the design which have been used to address functional requirements. It also embraces establishing user requirements, capabilities of the system, and architecture as a whole such that the app is user-friendly, efficient, and scalable.

3.1.1 Overview

Research methodology of BookNest was structured and systematic with the aim to present reliable, user-friendly, and efficient book-sharing platform that would be good at loaning, purchasing, and selling books. The proposed methodology was based both on the techniques of qualitative and quantitative research, as a result of which it was possible not only to receive the practical feedback of potential customers but also to confirm the technical and functional requirements according to the testing.

It was initiated with requirements collection as we were able to follow existing literature on sharing systems related to books, examine marketplaces that peer-to-peer mechanisms are based on, as well as engage in unofficial consultation with students, book-lovers and general members of the community. This assisted in establishing the gaps in the Bangladeshi market, which include a lack of centralized digital platform offering the possibility to borrow books and reselling them.

The approach which was used to refine system design was that of a prototyping. Initial versions were provided to be tested by target users and feedback was used to make adjustment to user interface, navigation flow and prioritization of features. This design, feedback, and adjustment loop was iterative and it made sure that the platform was meeting and addressing the actual user requirements.

The development relied on an agile strategy that made it possible to deploy initial functionality like authentication, book management, borrowing requests and payment

integration over time in an iterative manner. Every cycle of the sprint consisted of the planning, conduction, testing, and reviewing stages that ensured the adoption and responsiveness all through the project.

At last, system testing was performed to check functionality, usability and performance. Functional tests were used to test whether each module was behaving as expected, and non-functional tests helped to test the scalability of each, the security, and its responsiveness.

The given methodological framework allowed striking the right balance between the research-guided eye and technical precision and as a result, BookNest is not only technically sound but relevant, usable, and impacts its target users.

3.1.2 System Design

The system architecture of BookNest has been designed as a layered system that includes client, application and data services with integration with multiple third-party APIs in order to extend functionality (Figure 3.1). At the client level, there is a web browser on the user's end hosted in Netlify and this web browser communicates with the backend running in Vercel.

The central component of the architecture is the Application Server, which has the business logic of the platform, such as the processing of requests, management of books, and channelling of external APIs. For example, the Google Maps API offers geolocation and distance calculation services used to supply pickup point information, while external Book Data APIs (such as lookups by an ISA number), can fetch information about books automatically.

Secure payment procedures are handled by SSLCommerz that does the job for deposit, lending fees, recharge for wallet and withdrawal procedure. In addition Cloudinary has been Integration for the Image management, where book images and profile image are being hosted and its link are being stored in the Database ensuring that it utilises efficient storage and smooth retrieval.

The Request Handler plays the role of an intermediary so that there is a smooth coordination between the application server, APIs, and the Database. The database stores all the persistent information- this includes the user accounts, book records, pickup points, images and transactions as well as the requests for lending.

This modular and service oriented design makes sure BookNest not only remains scalable, secure and efficient but also provides an extensible framework for adding more services in the future.

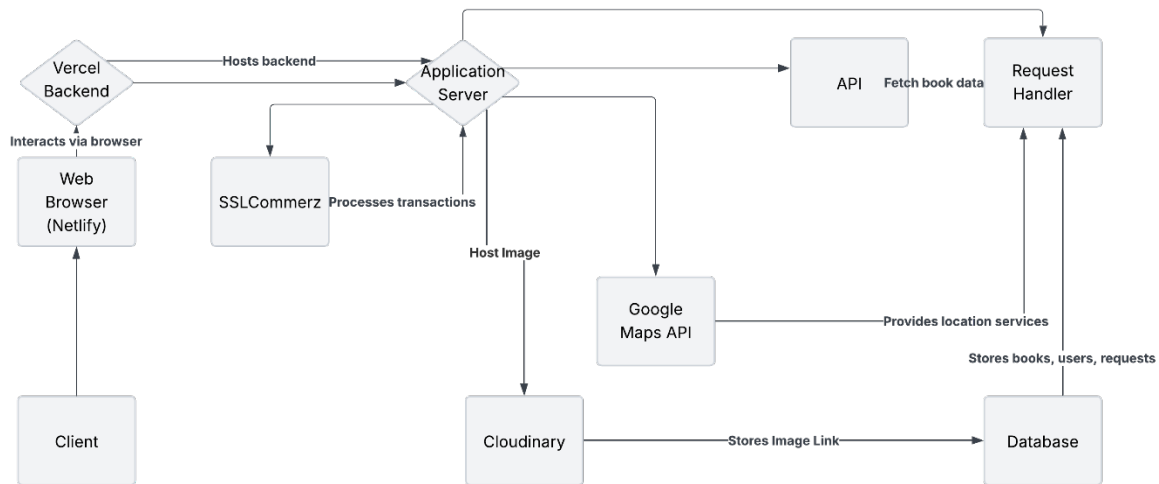


Figure 3.1: BookNest System Architecture Diagram

3.1.3 Functional and Nonfunctional Requirements

This section describes nonfunctional and functional requirements of BookNest application. Functional requirements give the main functionality of the system and define their behaviours, whereas nonfunctional requirements provide and outline quality attributes that must guarantee the system usability, its performance, and safety.

Functional Requirements

- i. Registration, and Authentication
 - a. The users can log in and/or register with email or phone number.
 - b. Passwords are safe with bcrypt
 - c. JWTs (JSON Web Tokens) are employed in order to secure session.
- ii. Book Catalog management
 - a. Lenders can place books on the list which can be lent, sold or donated.
 - b. The book items include Title, Author, Category, Condition and Images.
 - c. Cloudinary multifaceted feature is used to upload and optimize.
- iii. All ranks in search and filtering
 - a. Users are able to search books by category, title or by its author.
 - b. Distance-based search enables a user to filter books in the proximity of the user through Google maps API.
- iv. Borrowing, Resale, and Transactions.
 - a. The users are able to request to borrow books or purchase books.
 - b. The history of transactions is kept on each user.
- v. Ratings and Reviews

- a. Users are able to rate and review books and other people on the system in order to have some form of trust.
- vi. Admin Dashboard
 - a. Admin can control users, and verify transactions, can approve and/or reject book listing.

Nonfunctional Requirements

- i. Performance
 - a. The system should be able to support concurring users without interminable delays
 - b. The sound page load time is any time under 3 seconds.
- ii. Security
 - a. Along with encryption and secure protocols (HTTPS/TLS), data and credentials must be secured.
 - b. Domain based access control is embedded to create a restrictive access.
- iii. Scalability
 - a. It is modular, so it is relatively easy to scale it in the future, e.g. toward AI-driven recommendations or subscription-based features.
- iv. Reliability and Availability
 - a. The system needs to be kept up 99 percent with minimum disruption.
 - b. There should be consistency in data in all the transactions.
- v. Usability
 - a. UI must be intuitive and responsive to the user both on the desktop and mobile.
 - b. Navigation has to be easy and understandable and there has to be clear instructions of how to access core actions.
- vi. Maintainability
 - a. The modular and component based design will make it easy to carry out updates and bugs.
 - b. Front-end and backend of the code is well documented.
- vii. Compatibility
 - a. The software must be supporting the commonly applied browsers (Chrome, Edge, Firefox) and the devices (desktop, tablet, mobile).

By establishing specific requirements, BookNest strives to achieve the balance between

system functionality, user experience and system quality and that is why BookNest will be a reliable efficient system that using the peer-to-peer book sharing system.

3.1.4 Data Flow Diagram

The data flows of BookNest show how information is passed between various entities, processes and system modules and how this guarantees the smooth running of book sharing, book buying and book lending procedures. As can be seen in Figure 3.2, the flow starts with the identification of user types Guest, Registered User and Admin who have varying privileges and interactions with the system.

Guest can only browse books from categories such as Fiction/Mystery/Horror/Academic/Free Books etc. Their interaction with one another is restricted to the viewing of available resources without touching transactions.

Registered Users are given a full set of actions, such as adding books (images stored in Cloudinary for image and metadata stored in the database), managing pickup points using Google Maps integration and retrieving book information using the Gemini API, via forum by ISBN. They can demand books, can manage wallet, can start payment by using SSLCommerz and can complete book lending/selling process. Critical functions include:

- i. Requesting a book and processing payments with opt. security deposits
- ii. Confirming the handover of the book with the help of PIN verification.
- iii. Returning books verified through OTP with deposits refunded/transferred on the basis of conditions.
- iv. Reviewing books and users when the transactions are completed.

Admin Users manage the platform by managing the books (publishing or hiding it from the listing), by monitoring the transactions with advanced filtering (by ID, by status, by a date) and by controlling the user accounts (blocking/unblocking). Admins hence ensures the integrity, transparency and security of the overall system.

Data runs continuously back and forth between Application Server and Database along with integrated APIs (Google Map, SSLCommerz, Gemini, Cloudinary) that allows the seamless coordination of the book management, transactions and user activities.

This disciplined flow of book management enables consistency for usability, security and scalability, and helps provide a consistent experience for all user roles.

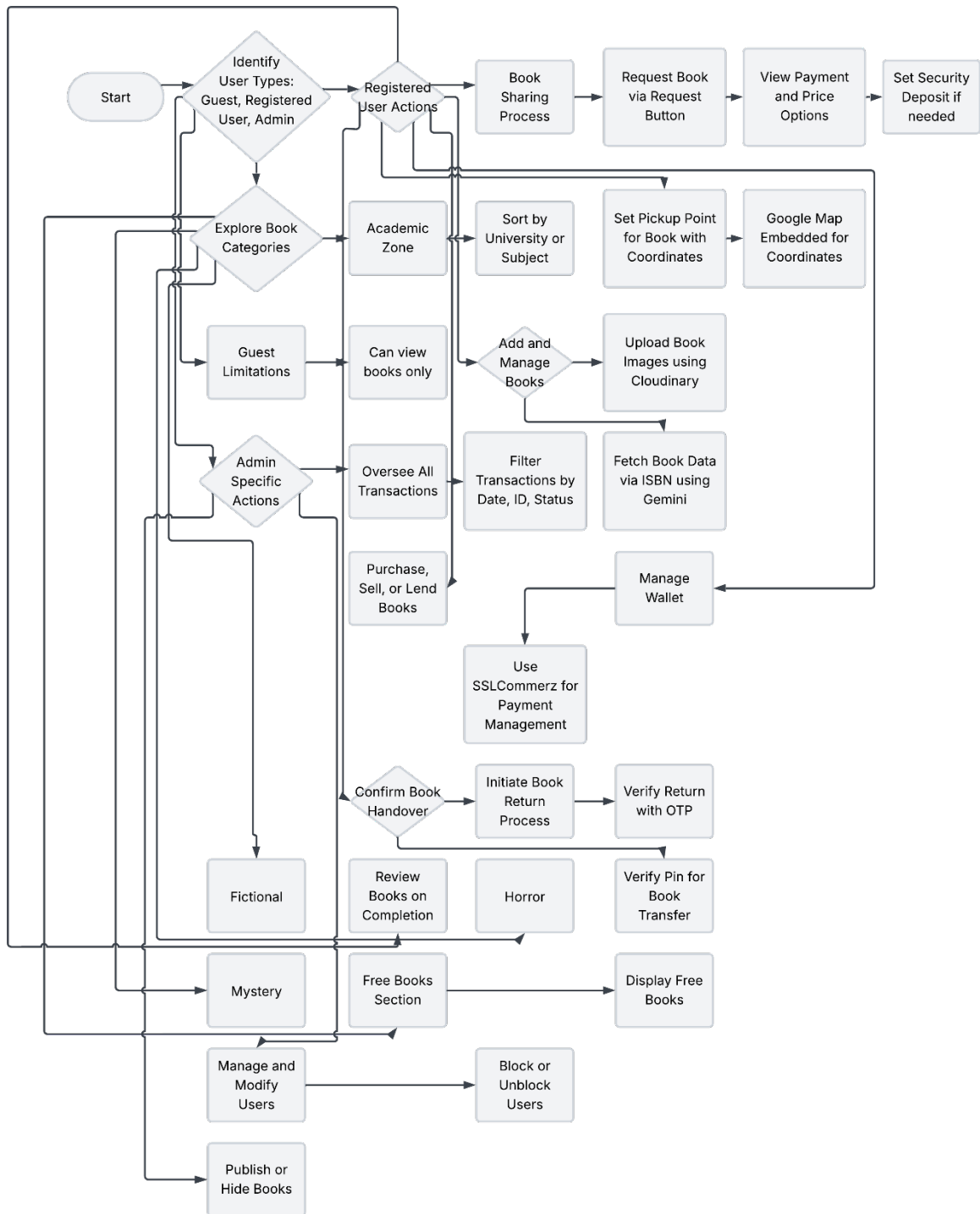


Figure 3.2: Data Flow Diagram of BookNest

3.1.5 Sequence Diagram

BookNest is a peer-to-peer book sharing platform, which aims at advancing the security and convenience of lending and borrowing books between users. The process starts with a registered user goes through the available books after using a variety of filters such as genre, academic category, distance, categorisation universities, and subject wise search.

Once a user finds a book which is open for lending, the user can send a request for lending it via the platform. At this stage, there it is also possible for the requester to place an optional note to add context or message to the book owner.

On the other end, the book owner gets this request into their manage requests section, or their listings for their book. They then can accept or reject the request. If the system is accepted, then the system goes to the payment stage. The requester is eased through to complete the payment, which may comprise of lending fee and security deposit based on book owner's selection settings. The payment is processed through the integrated SSLCOMMERZ gateway and the deposit amount are securely retained in the system's Escrow until the completion of the lending transaction.

After the payment is made a successful payment, the system make the contact information of the requester and the book owner available to each other to setup a pickup. The users then meet at the agreed pick-up point that was mapped earlier by the book owner using a Google maps integration. At the time of handover, the requester needs to provide one system generated PIN that verifies the fact that he/she has received the book. Once the PIN is entered and validated, the fee for the loan is freed to the owner of the book, while at the same time the security deposit is kept in temporary custody.

The book return process starts when the end of the period of borrowing arrives. The product owner visits the pick up point again to return the book and receives an OTP to check the appropriate return of the book. If the OTP is verified successfully then the system returns the remaining deposit to the requester deducting the only fee for the lending. However, if the borrower doesn't return the book within the agreed time frame, the return of the deposit can be taken by the book owner in full. Upon approval of the claims full amount of the deposit is credited to the book owner's wallet.

Once the transaction goes through, both users are then given the choice to provide reviews for one another as well as for the book to be read, fostering a light of transparency and trust in the BookNest community. This end-to-end process allows a secure, traceable, and easy-to-use lending and borrowing books experience.

The following figure illustrates the complete sequence of this book sharing process whereby different components of the system interact with each other and the users.

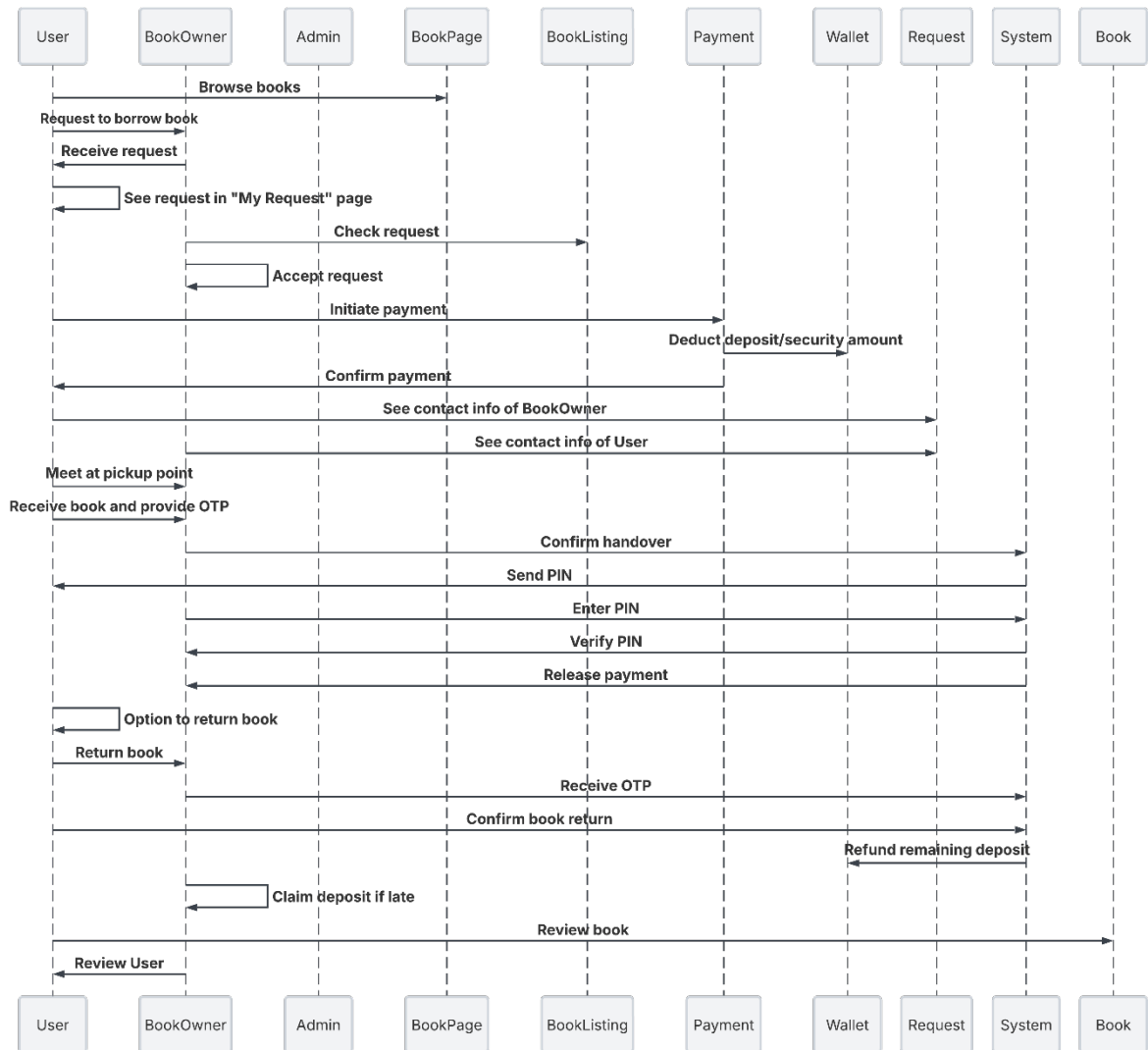


Figure 3.3: Book Sharing Sequence Diagram in BookNest

3.1.6 Entity-Relationship (ER) Diagram

The data model of BookNest is built to support the peer-to-peer book sharing it supports with keys to the data and a well made schema. At the centre of this model is the User entity which represents all those registered on the platform, both regular users and administrators. Each user record stores fundamental profile properties such as the user's name, email address, phone number, address, and profile image, plus features that reflect the user's status (UserType), their account status (IsBlocked) and wallet balance (CurrentBalance). Users are involved in various sections of the system such as listing of the books, controlling pick up points, payment transactions, requests and reviews.

Books which have been enumerated for lending or selling are represented by the Book entity. This entity has important information such as title, isbn, author, category, condition, availability, description and price. Each book is linked to a User as owner of

the book (BookOwnerId) and a PickupPoint as where the book is being collected. These pickup points are created by users and will contain fields for a location name, address and geographic coordinates to, for instance, allow distance based filtering. Relationship between books, users and pickup points to ensure that each listing can be traced and is contextually accurate.

For the process of borrowing/buying is carried out from the Request entity, which represents user's interaction with books. It tracks information on the requestor, book and owner, as well as other variables, for example, notes, payment status and state, deposit state and amount, lending period (via ReturnDate), and other flags indicating whether the book has been handed over, returned or reviewed. This entity is the nucleus of the handling full life-cycle of a transaction. As we see from the Request model in Figure 3.4, it is directly related to two entities: User and Book, because it is a transactional bridge between borrowers and lenders.

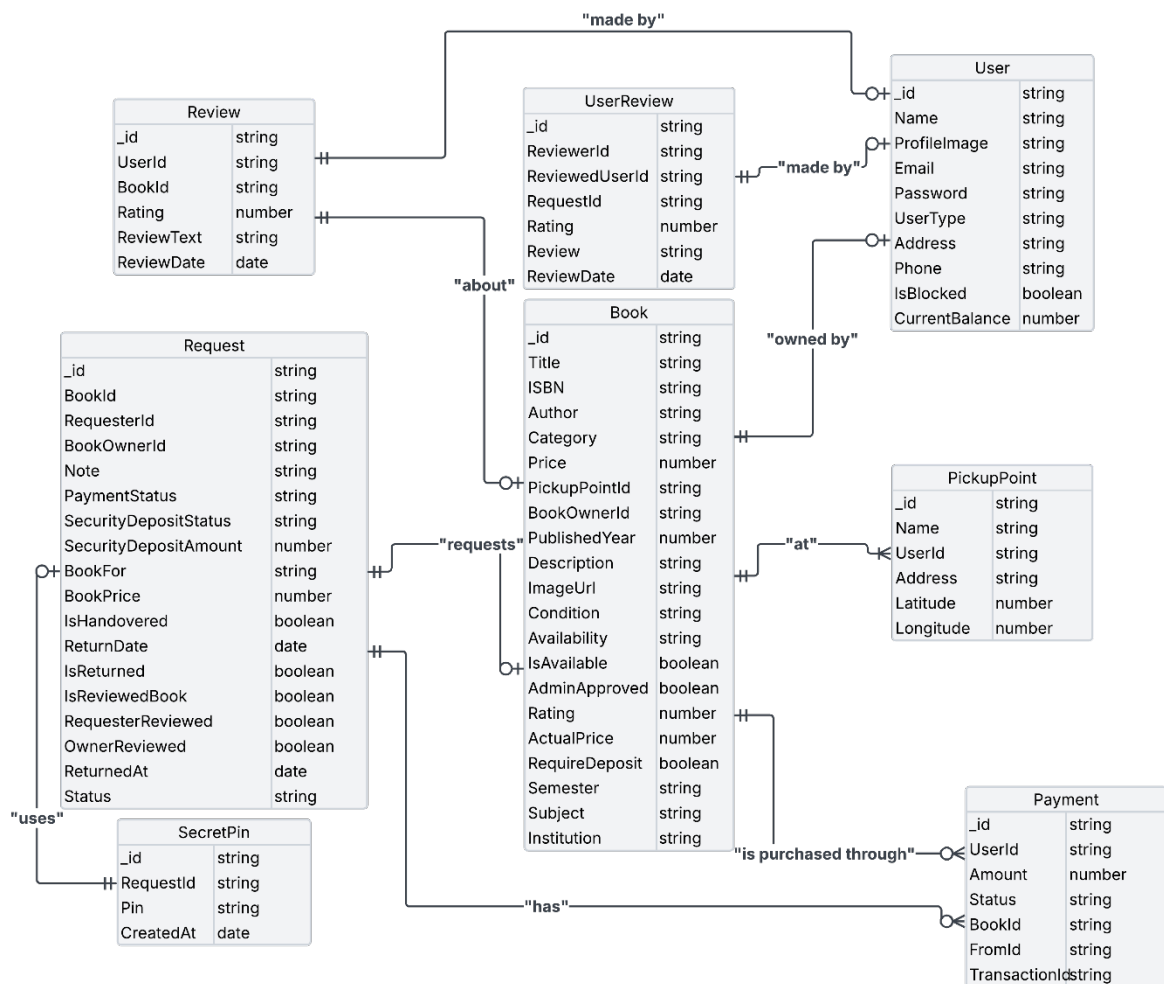


Figure 3.4: Entity-Relationship Diagram of BookNest

To manage the money flow of the platform, the Payment entity holds information about

each transaction-what is the user, how much they've paid, status of the transaction, the book reference, and what is transaction ID. These payments may be to lending fees or as security deposits, depending on the book owner's preferences. Security during book handovers due to the SecretPin entity: a temporary, expirable PIN is generated, associated to a given request. This PIN needs to be verified prior to the owner receiving the fee from lending, in order to maintain trust and accountability in real-world exchanges.

Finally to promote community engagement and connection of trust, BookNest also supports two forms of reviews. The Review entity enables User to rate and comment on books he has taken UserReview entity allows User to Response User after completion of transaction. These entities include reviewer identity, ranking, content of review, and date, and are tied back to particular requests for traceability.

Together, the entities and relationships defined in the ER diagram are a solid basis for BookNest's major features--safe book lending, request management, real-time payments, and user reviews. This is a model that ensures data consistency, normalization and scalability for the future, which also supports the implementation of user experience in a very smooth and trustful way across the platform.

3.1.7 UI Design

The User Interface (UI) of BookNest is designed and designed simple, consistent and yet friendly so that the various users-partner, guests, registered users and admin can navigate provided seamlessly. The whole design is led by the use of a minimal gray color scheme so that the content is the main focal point. Each section of the platform offers a visual aid with organized layouts and functional elements that make it sure to afford clearness of operation.

Landing page and browsing the book

The landing page is the first place the users interact with. It shows an organized catalog of book separated into various categories like Fiction, Horror, Mystery and others. In addition, specially prepared and je to improve the tit browsing:

- i. Free Book Section lists all books which you can have free of cost.
- ii. Academic Zone for implementation as academic materials being hyper advanced filtering capabilities such as a filter for distances, university wise search, subject wise, and sorting mechanisms.

The interface makes sure that even a guest (unregistered user) can access the catalog and browse the available book but he/she will not be able to borrow, buy and sell books unless and until he or she is registered.

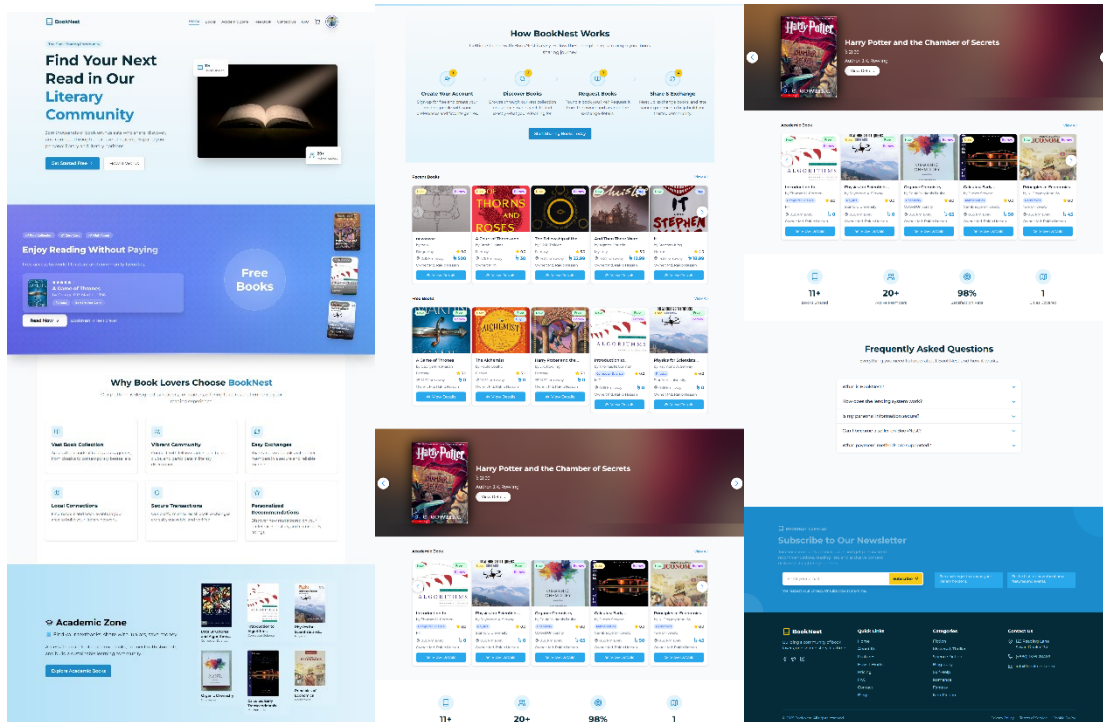


Figure 3.5: Landing page of BookNest

As shown in Figure 3.5, the landing page lets category listings be combined with free books and academic books.

User-Specific Interfaces

Once a user is logged in, a registered user has access to their personalised account dashboard with several sections:

a) Add Book Section


Users can add books to lend / to sell. If a book's CIS element (ISBN) is available, the system connects with the Gemini API and automatically retrieves the metadata information complete, doing so ensures that book information is automatically populated. Before submitting users must choose a pick up point. This occurs via an interactive Google Map integration where the co-ordinates and address are stored. The process is efficient when adding a book as a lineup of all of your previously saved pickup points is presented in a dropdown menu. This workflow is modelled in figure 3.6 and 3.7 this corresponds to the Add Book Form with ISBN fetch and pick up point selection.

Add Your Book

Share your book with the community

Book Information

Book Cover



Upload book cover
PNG, JPG up to 5MB

[Choose File](#)

Title *

Author *

ISBN *

Category *

Condition *

Published Year *

Description

Brief description of the book

Availability & Pricing

Availability Type *

For Lending
Allow others to borrow

For Sale
Sell permanently

Landing Fee *

I require a security deposit ?

Pickup Location

Select Pickup Point *

Preview

Book Title

by Author

Fiction - Condition - Year

Stock: 0

Admin Approval Required

Your book will be reviewed by our admin team before it becomes available.

Figure 3.6: Add Book page of BookNest

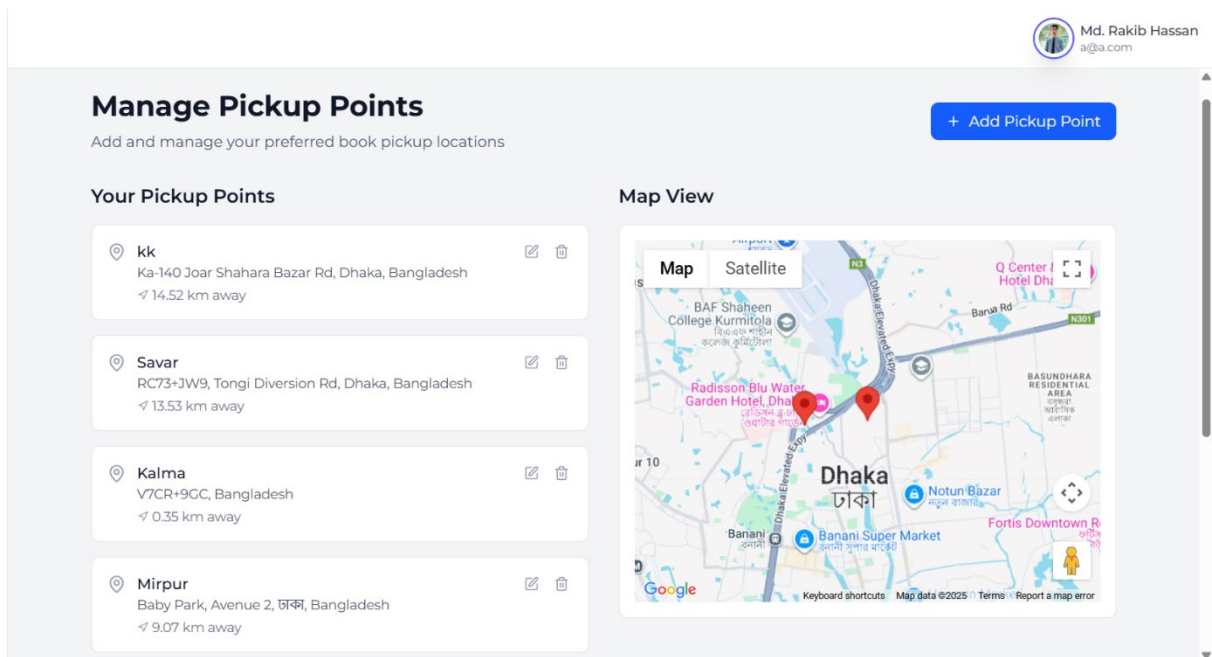


Figure 3.7: Pickup Point page of BookNest

b) My Books Section

This section gives a full overview of all books listed by user. Pending books are highlighted as not published until an administrator approves books when they will be visible to others for lending/selling.

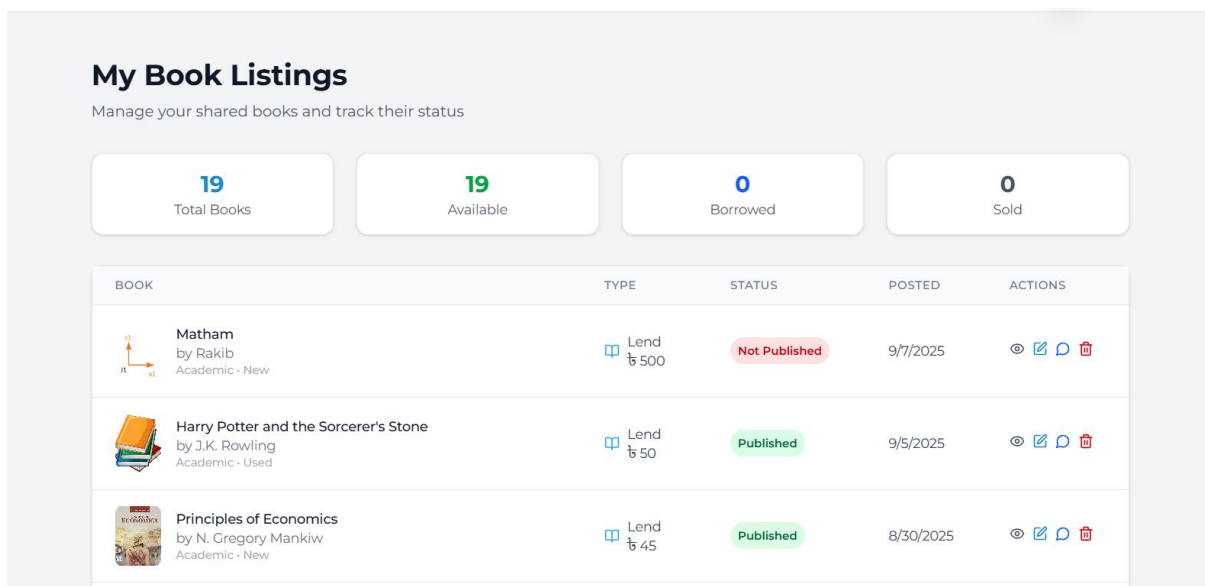


Figure 3.8: My Books page of user in BookNest

As you can see from Figure 3.8, we have clearly described the distinction between Pending and Approved book listings in the interface.

c) Request Management

The request system is broken up into two parts:

My Requests shows the list of all requests which were triggered by the user and their status (Pending, Accepted, Completed etc.).

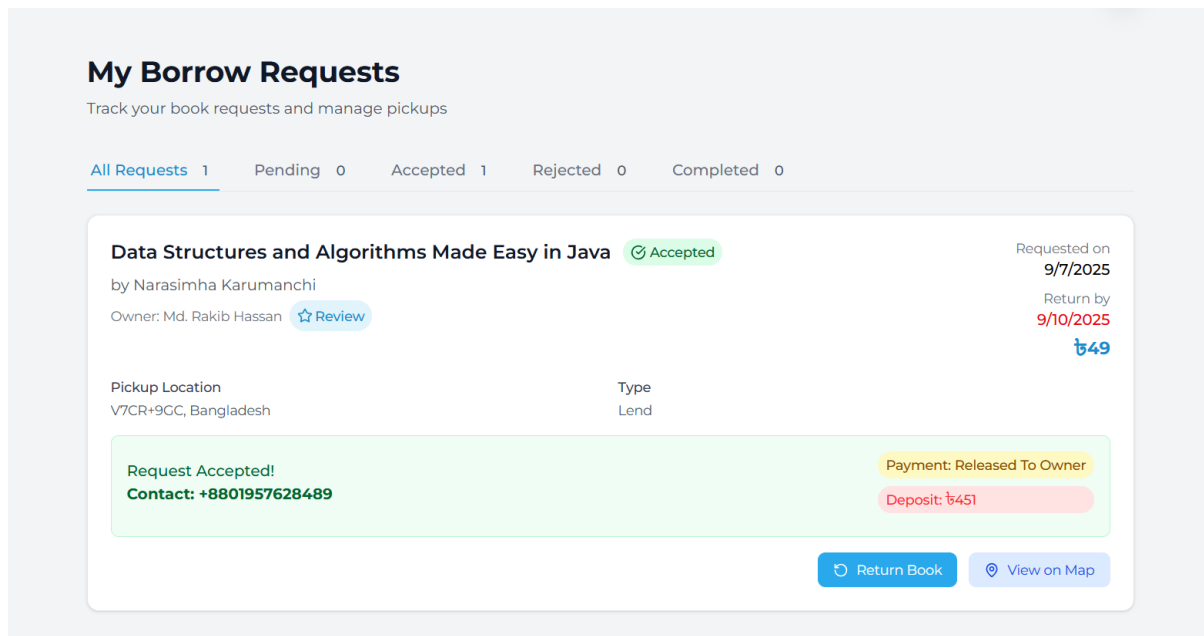


Figure 3.9: My Request page of BookNest

Manage Requests is offered to book owners with a combined view of all borrow or purchase requests on their books. From this they can accept or reject a request.

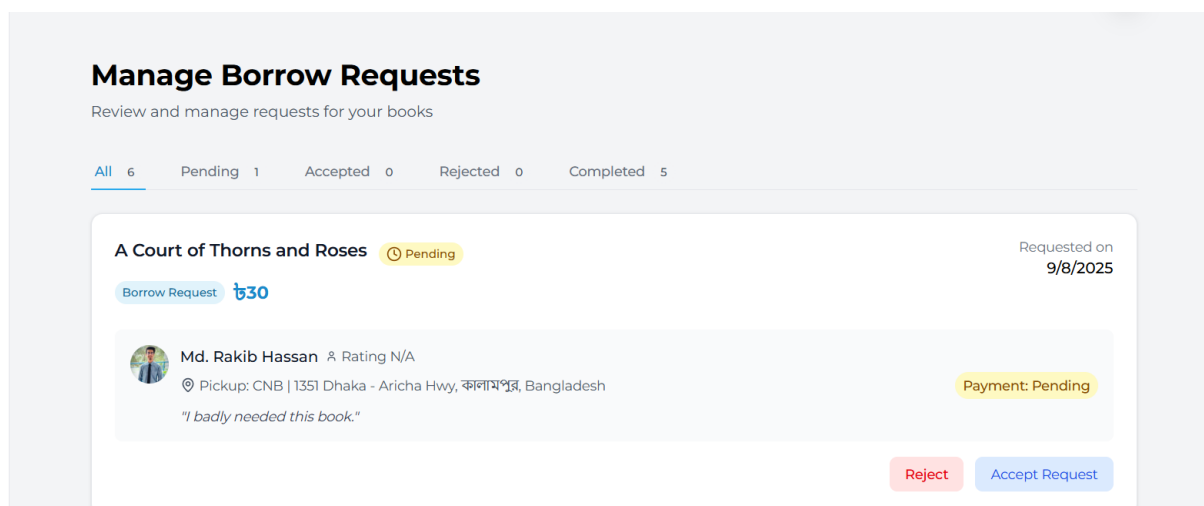


Figure 3.10: Manage Request page of BookNest

A concise representation of this process is available in the figure 3.9 and 3.10, which is shown from a requester's point or view as well as an owner's point of view.

d) Wallet

The wallet interface offers safe environment for financial transactions with the SSLCommerz. User can deposit or withdrawal amount and record of every transaction is shown on chronological basis. Status indicators are provided to make transactions of completed, pending or failed jobs clear. The interface to the wallet and a detailed log of the transactions are shown in figure 3.11

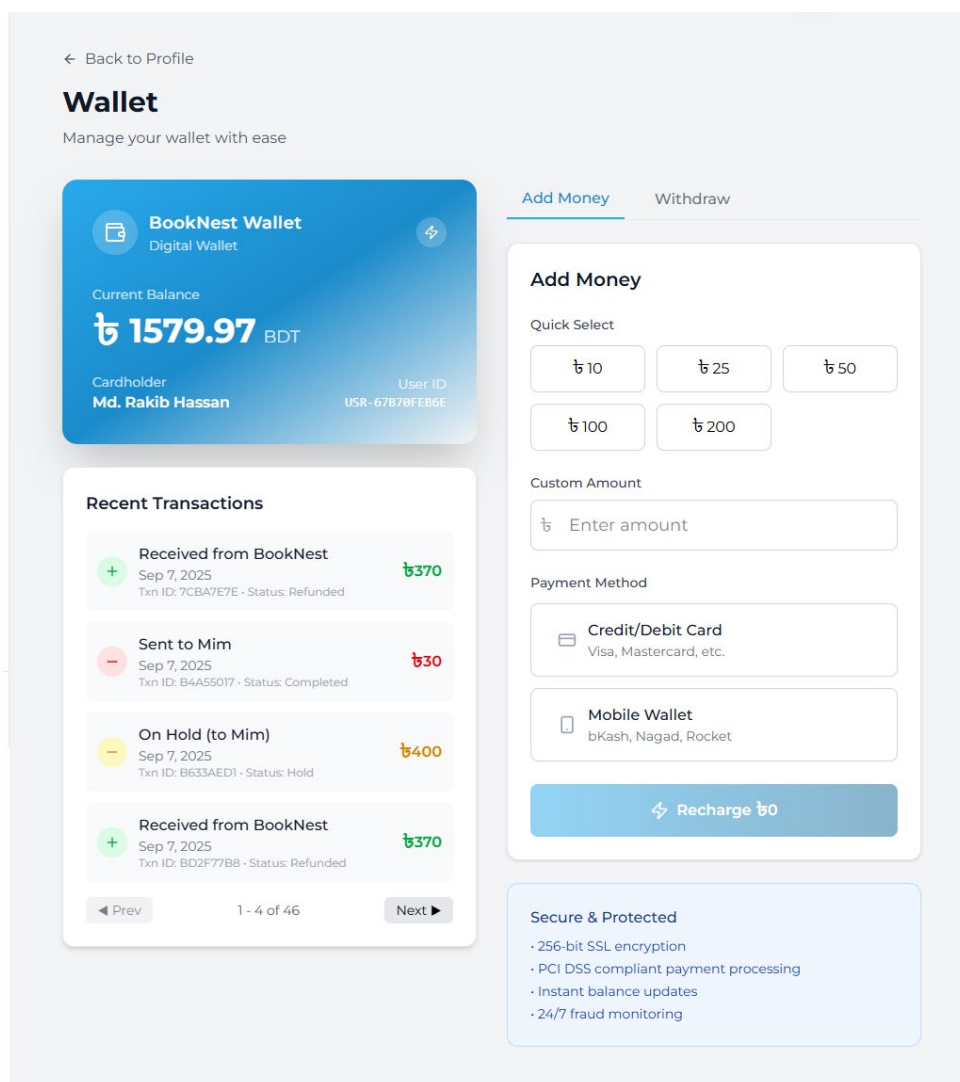


Figure 3.11: Wallet page of BookNest

Testing (Book Sharing Workflow Interface)

The book sharing workflow is specially designed for transparency and security. When the user locates a available-for-lending book, the user can make a request of such a book by clicking on the Request button. A popup dialog (Figure 3.12) gives them a chance to add a note prior to submitting.

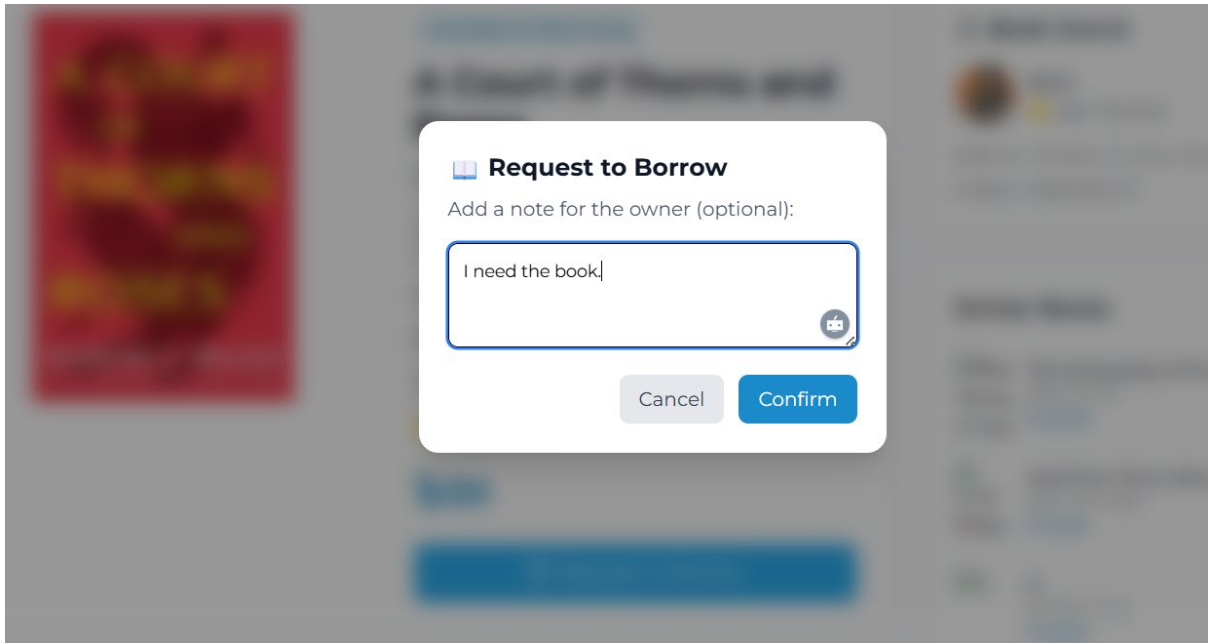


Figure 3.12: Borrow request Confirmation popup with note.

On the side of the requester, the request is displayed in My Requests in which the payment options are displayed. In cases where the return of deposit is required by the owner, the system stays hold of the deposit until the book is returned. On the owner's side, requests are shown in Manage Requests where owner can accept or decline them (Figure 3.13).

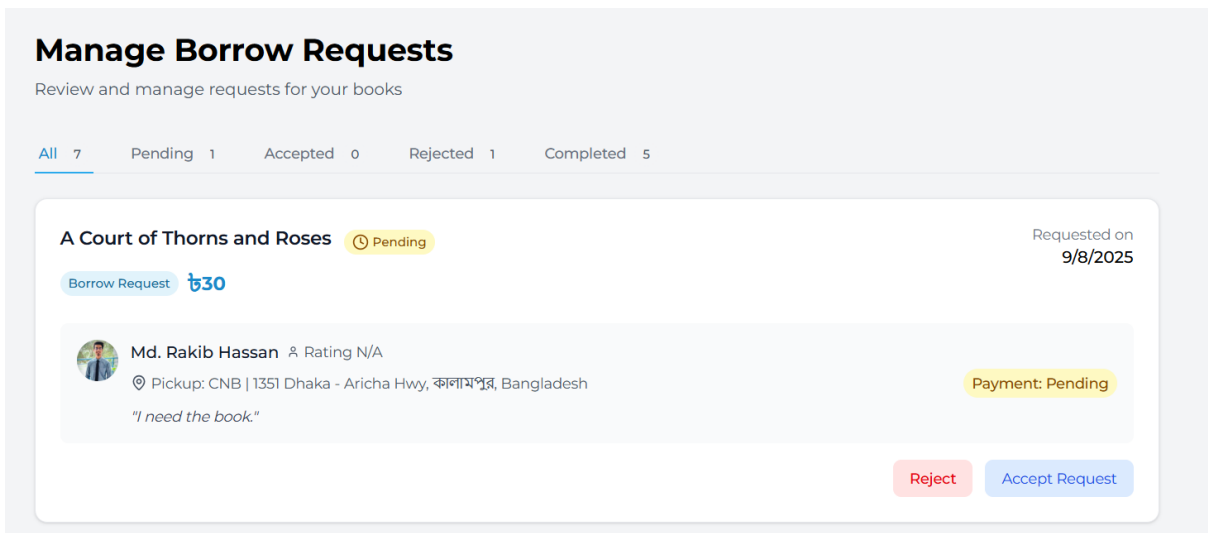


Figure 3.13: Waiting for book owner decision

During the handover process, one uses a PIN verification system after the payment, which verifies that the transfer of the book is to the correct person. Similarly, in the return process also, one OTP mechanism to ensure a book has been returned.

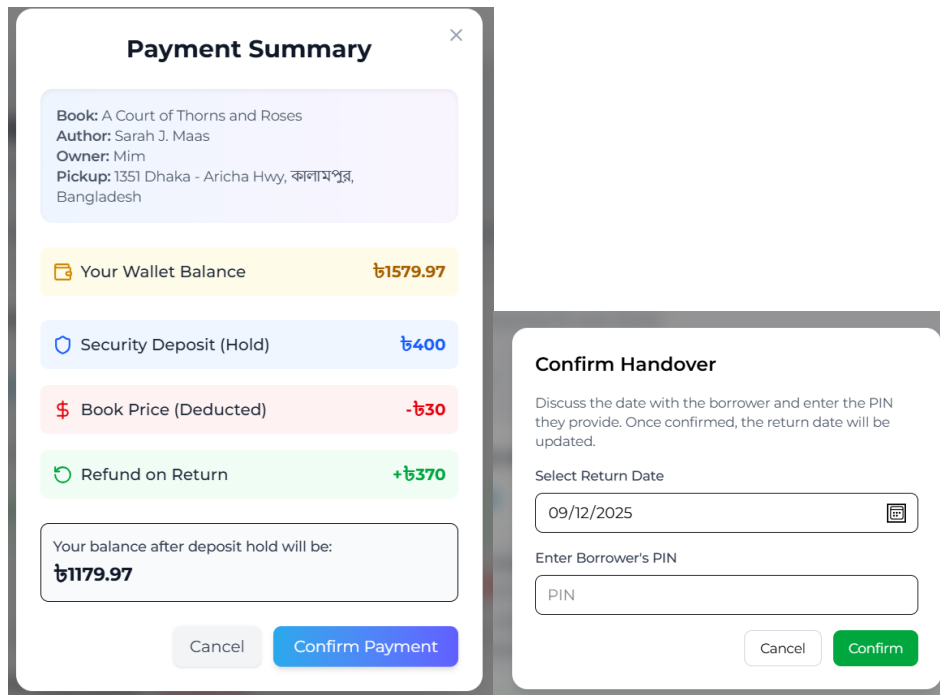


Figure 3.14: Payment from requester and otp verified from owner side.

The visual representation of this workflow step-by-step can be seen in Figure 3.14 which demonstrates the popup of a request, payment flow and verification stages. And if the book is not return before due date then book owner can claim the security deposit amount as shown in Figure 3.15

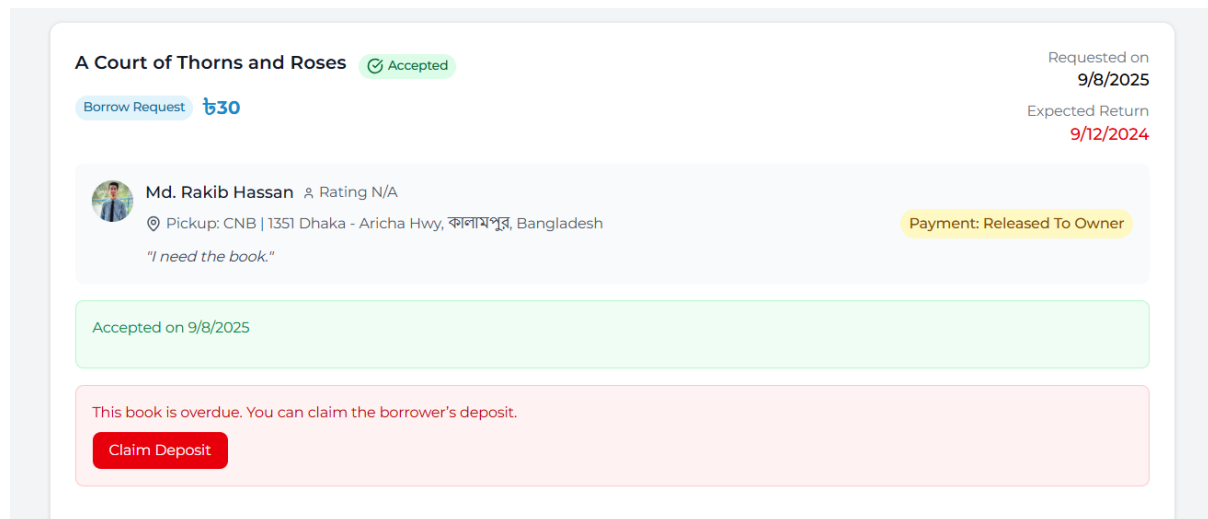


Figure 3.15: Security deposit claim by bookowner

Admin Interface

The administrator dashboard has both functionality and control oriented with the abilities for the admin to manage users and books and controlling financial transactions.

Manage users: Admins are enabled to block or unblock users as needed as shown in Figure 3.16.

Manage Users
View and manage user accounts

Search users...

USER	ROLE	PHONE	STATUS	ACTIONS
Jazxne Smith jasdnedsmith@example.com	User	+1 5555-987-6543	Blocked	Unblock Details
John Doe johndoe@example.com	Admin	+1 555-123-4567	Active	Block Details
Md. Rakib Hassan a@a.com	Admin	+8801957628489	Active	Block Details

Figure 3.16: Manage user by admin

Manage Books - Pending books can be published and inappropriate list hidden. Search and filter tools make the navigation efficient shown in Figure 3.17.

Manage Books
View, publish, and manage book listings

Search books... All Books

BOOK	CATEGORY	PRICE	STATUS	OWNER	ACTIONS
The Fellowship of the Ring J.R.R. Tolkien 1954	Fantasy	₹ 22.99 Used	Pending	Md. Rakib Hassan a@a.com	Publish 🗑️
And Then There Were None Agatha Christie 1939	Mystery	₹ 13.99 New	Approved	Md. Rakib Hassan a@a.com	Hide 🗑️
It Stephen King 1986	Horror	₹ 18.99 New	Approved	Md. Rakib Hassan a@a.com	Hide 🗑️

Figure 3.17: Manage Book by Admin

Transaction Monitoring: Admins can view all of the user's transactions, accompanied by well-rounded filters like search transaction ID, payment status, and select date. These features are represented in Figure 3.18.

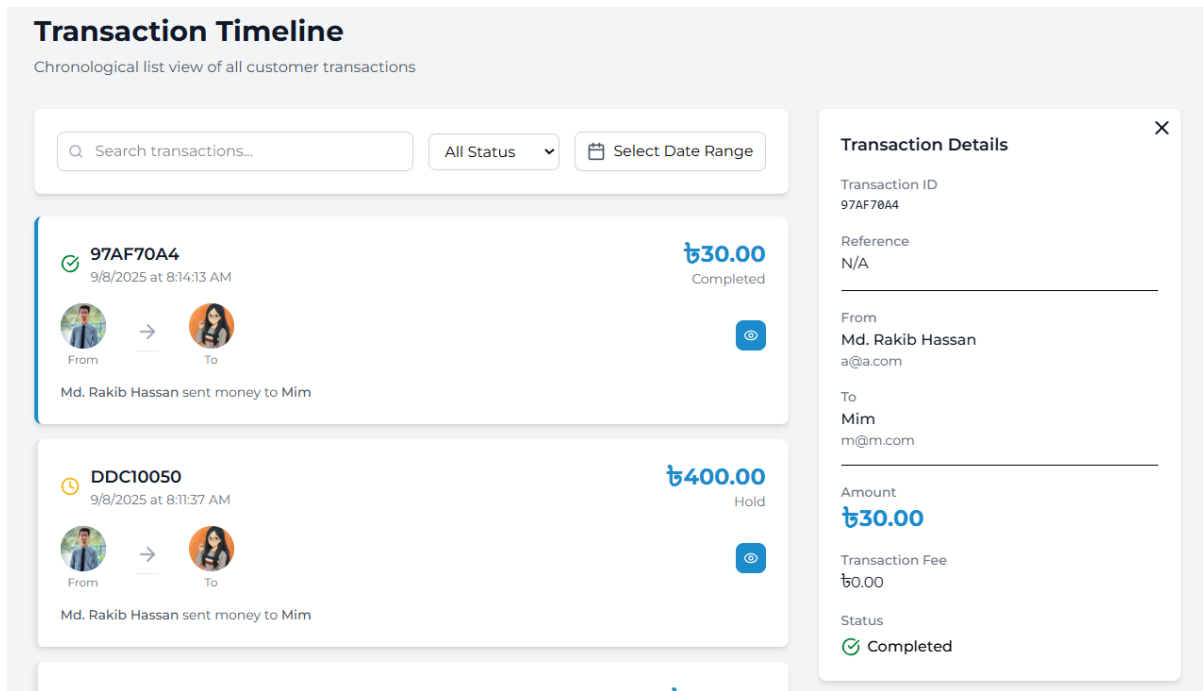


Figure 3.18: Transaction Monitoring by Admin

3.2 Detailed Methodology and Design

The technique used and structure of BookNest were fixed in the manner that made it scalable, easy to use and efficient peer-to-peer book sharing space. Several alternative solutions were considered at every stage of development and the best possible decisions were made taking into consideration the cost-effectiveness, usability, and the technical feasibility.

Alternatives in the Frontend Development

Option 1: Vanilla HTML, CSS, and JavaScript -In this method, complete control over design would have been possible but this could have been quite time-consuming and had limited component-reuse.

Option 2: Angular Framework - This provided structured development and data binding but it has a very steep and learning curve and the bundle size is larger which may present performance issues to the students with low end devices.

Solution adopted: React.js + Tailwind CSS - React made the style pieces modular and reusable, effective state management and a community. Tailwind CSS made it easy to apply style and responsiveness to the UI with minimal amount of custom CSS and made it lightweight and aesthetically pleasing.

Back End Development Options

Option 1: PHP and MySQL- Powered by MySQL, and it is widely used and easy to deploy but unsuitable because of the contemporary RESTful API driven applications.

Option 2: Django (Python) - Secure and scalable but a heavier option on a small student project and it needed to learn an additional stack: Python.

Chosen solution Node.js with Express.js and MongoDB (MERN Stack) Node.js supported the possibility of asynchronous operations, and a unified language base in the stack. Express.js also offered flexibility with API routing whereas MongoDB was a document based schema that was much more suited to the dynamic format of book records and user data. Free hosting of MongoDB Atlas in the cloud also cut the costs.

Other Image/media Handling Options:

Option 1: Store on local server -easy to put in place, but it would put an extra load on the server and complicate the deployment.

Option 2: self-hosted cloud storage - Secure and scaleable but involved additional configuration and it might be expensive in terms of cost.

The solution that was chosen is called Cloudinary the free-tier is offered that makes a maximum of 25,000 image transformations per month and offers automatic optimization, CDN delivery, and straightforward API integration, which simplifies backend work.

location based Features Alternatives:

Option 1: Manual address input to filter on distances - a basic solution that makes it easy to introduce errors and that must calculate complex distances in the back end.

Option 2: Non-commercial geolocation libraries - Free, and fairly inaccurate with regard to locations in Bangladesh and also have limited documents.

Google Maps API - Free-tier API provided the capability to perform effectively geolocation, measure accurate distances and visualize data on a map, improving user experience and keeping infrastructure costs low.

Possible Authentication and Checking Options:

Option 1: Session based authentication- Easy to apply but lacks security in APIs.

Option 2: Third-party OAuth services -Easy to use, required external resources and might have the limitation of users.

Using: JWT (JSON Web Tokens) with bcrypt - has provided a secure stateless

authentication, it has allowed encrypting the password storage and then implementing it easily on the MERN stack.

The design phase involved iterative prototyping wherein each module (user registration, book catalog, borrowing/reselling workflows and payment integration) was created and showed to the user to measure the feedback and fine tune it in each turn. The architecture was organized about modular principles, whereby separation of concerns could be achieved and expanded on in the future like the introduction of add-ons like premium features, subscription, and/or AI-based recommendations of books.

In this work, the decision-tree-solution (DTS) method was utilized to identify the appropriate solution(s) based on multicriteria optimality that determined the technical feasibility, cost, and user experience of each alternative. As the result, BookNest has an effective, sustainable, and expandable system to share books peer-to-peer in Bangladesh.

3.3 Project Plan

The organization of the development work of BookNest was based on an elaborately designed project plan that ensured structured development in the different stages of the work. Since this was an individual effort it was all an effort to balance requirement analysis, system design, implementation, testing, and documentation in a sequential but iterative fashion. The project's initial phase started with a requirement analysis and literature review, where existing peer-to-peer book sharing platforms were analysed to find the gaps present within the Bangladeshi scenario. This very early research helped finalise the functional and non-functional requirements used to guide the rest of the development. Following this, the system design phase was begun in which, in addition to diagrams such as the data flow diagram, the entity-relationship model and the sequence diagram, prototypes of the user interface were prepared. A consistent gray theme UI was selected because it allowed simplicity and readability which helped to make sure content was the focus and not unnecessary design elements.

Once the design was finalised, implementation began with frontend development using the React.js [5] and Tailwind CSS [6], followed by the development of backend using Node.js [2] and Express.js [3]. At the same time, MongoDB schemas were designed to store data of user, book, request and transaction in a scalable way. As implementation progressed, additional external services were added such as: Google Maps to look up pickup points, Gemini API to look up the ISBN, Cloudinary to store our image and SSLCommerz for payment integration. The integration was accompanied by testing phases where unit, integration and user-based testing helped ensure that flow-of-work, such as borrowings, lendings, deposits or returns happened seamlessly. Towards the end of the project a detailed documentation phase was done in order to bring together diagrams, system specifications and screenshots of the implemented interface, which



resulted in preparation of the final report as well as the presentation materials.

3.4 Task Allocation

This table depicts the timeline of the principal activities in each period of the project, from week 1 to week 37.

Table 3.1: Task Allocation

Tasks	Weeks																		
	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37
Requirement Analysis	Estimated	Estimated	Estimated																
	Actual	Actual	Actual	Actual															
System Design				Estimated	Estimated	Estimated	Estimated	Estimated											
				Actual	Actual	Actual	Actual												
Frontend Development									Estimated	Estimated	Estimated								
									Actual	Actual	Actual								
Backend Development												Estimated	Estimated	Estimated					
												Actual	Actual	Actual	Actual				
Testing & Debugging															Estimated	Estimated			
															Actual	Actual			
Deployment																	Estimated	Estimated	
																	Actual	Actual	
Documentation & Reporting																		Estimated	Estimated
																		Actual	Actual

Estimated 
Actual 

3.5 Summary

In summary, the whole research methodology, designing and developing plan of the BookNest platform were given in this chapter where the requirements were collected, analyzed and drawn into trying and non-capable specifications. The complexities of this process were depicted in the chapter using the layered system architecture which integrates third party services like Google Maps, Gemini API, Clouinary and SSLCommerz and aided by graphical representation means of data flow, sequence and entity relationship model to demonstrate the internal processes. It focused on how the platform was designed to support features such as secure authentication, book catalog management, borrowing and resale flow, wallet transactions and admin oversight for all while providing performance, scalability, and usability. The user interface was described in terms of separate sections for guests, registered users, and administrative users and complemented by a minimal

gray- theme for clarity and consistency purposes. Alternatives for frontend and backend technologies, image management, geolocation, authentication, etc. were carefully reviewed and technologies have been selected from the MERN stack and accompanying tools mainly for efficiency and scalability. Finally, in the project plan described the timeline from the beginning of the requirements analysis and design, implementation, testing, and documentation of how the system developed in an iterative fashion as an individual effort with all of the BookNest requirements mellowed into a reliable and user-friendly peer to peer book sharing system.

Chapter 4

Implementation and Results

This chapter will explain how BookNest has been implemented, including its required environment, how the implementation has been tested and evaluated, performance analysis, and the results of the implementation. It illustrates the workings of the designed system in practice and examines its efficacy in sealing the gaps identified in the previous chapter.

4.1 Environment Setup

The BookNest application is built on the MERN stack (MongoDB [4], Express.js [3], React [5], Node.js [2]) in order to offer a full-stack solution. Responsive and animated UI components were done in Tailwind CSS [6], and Framer Motion. The RTK Query was adopted as a state management tool and to communicate with the API. VS Code was used as the IDE, Node.js [2] v20 as a backend and MongoDB [4] as database hosting software. The testing was completed on Windows 11 using the Chrome and Edge browsers to test cross-browser compatibility.

4.2 Testing and Evaluation

BookNest was tested in terms of functionality, usability, and performance verification to ensure that all the significant features are working properly. Testing involved user registration, log in, book lending, borrowing procedures, and distance-searching and map searching functions are summarized in Table 4.1.

Table 4.1: Test Cases and Results

Test Case ID	Feature Tested	Test Scenario	Test Input	Expected Output	Actual Result	Status
TC_01	User Registration	Register new user with valid email & password	Valid email, password	Account created, user redirected to home screen	Account created, dashboard loaded	✓ Passed
TC_02	User Login	Login with correct credentials	Registered email & password	User logged in, dashboard loaded	User logged in successfully	✓ Passed
TC_03	Upload Book	Upload a	Book title,	Book	Book listed	✓

		book for lending	PDF, description, image	appears on user dashboard	successfully	Passed
TC_04	Borrow Book	Borrow a book from nearby user	Select book, confirm request	Borrow request sent, user notified	Borrow request processed	✓ Passed
TC_05	Distance-Based Filter	Find books within a radius	Set location & distance filter	Nearby books displayed on list & map	Books displayed accurately	✓ Passed
TC_06	Map-Based Book Location	View book location on map	Click on book location icon	Map shows exact location of book	Map loaded correctly	✓ Passed
TC_07	Transaction Workflow	Complete peer-to-peer transaction	Lend or borrow book	Transaction recorded & status updated	Transaction successful	✓ Passed
TC_8	Multi-Device Responsiveness	Access system on different devices	Open on desktop, tablet, mobile	UI renders correctly	UI responsive on all devices	✓ Passed

4.3 Results and Discussion

The adoption of BookNest shows a complete functional system that weathers the shortcomings of the current systems a very editable book circulation system. Users are able to register, log in and lend and receive books from a peer-to-peer with all activities being documented and traced through a defined workflow. With the distance based filter, one can find out where the books are available nearby, and the maps based book positioning give very precise geolocation state providing better opportunities to access books in local environments.

Testing results indicate that all the intended core features such as uploading books, borrowing requests and transaction works as expected, and are updated in real-time on connected clients. The preliminary user trials have shown that the interface is very satisfying, the books are easy to find in a home environment, and the various steps of borrowing are clear.

When comparing with the current services like Rokomari [7], MylibraryBD [42],

BookMooch [36], BookNest provides more functionalities, such as the use of structured borrowing process, geolocation and peer-to-peer lending where others lack or are limited to offer. Generally, their findings show that BookNest is actually useful in the form of a localized, practical and usable attracting resource in terms of the book circulation in Bangladesh utilizing both digital accessibility and community-based physical interactions.

4.4 Summary

This chapter has outlined the design and evaluation of BookNest including the development environment, the testing process, the performance evaluation and the outcome. The program was created using the MERN stack with Tailwind CSS [6], Framer Motion [43] and RTK Query [44], to create a responsive and full-stack application, which was tested on Windows 11 in various browsers. Functional, usability, and performance tests verified that basic functionality user registration, allowing the user to log in, uploading the books to share, peer-to-peer lending and borrowing facilities, distance-based filtering, locating the books on the map, a workflow of the transaction, responsiveness of the design across multiple-devices, etc. -all work and are optimally efficient, with real-time updating of the same on interconnected clients. The findings show that BookNest is an efficient way of covering the gap present in other existing platforms by offering strict borrowing procedures, accurate geolocation to locate nearby books, and P2P circulation which would be more local and useful in these particular levels than current platforms available to people of Bangladesh like Rokomari [7], MyLibraryBD [41], and BookMooch [36]. On the whole, BookNest can be characterized as a convenient, time-saving, and community-based alternative to the circulation of both digital and physical books in Bangladesh.

Chapter 5

Engineering Standards and Design Challenges

This chapter explains the standards along with the engineering decisions made throughout the design and development of BookNest. It focuses on the adherence to software, hardware, and software communication standards and then the effect of the project on the society, environment, and sustainability. The chapter also introduces financial analysis and project management, as well as mapping BookNest against complex engineering challenges, knowledge profiles and engineering activities, offering an insight into encountered design challenges and methods employed to resolve them.

5.1 Compliance with the Standards

In any software project there are sets of standards that need to be followed in order to guarantee quality, reliability, security or future usability issues. Standards adherence ensures that the system is designed on best-practices in system design, development and deployment and will be interoperable with the existing systems. In the case of BookNest, adherence to software, hardware and communication specifications not only facilitates seamless operations, but also provides consistency with the rest of the world in such aspects as ease of use, accessibility and security. The measures of compliance are discussed in the following sub-sections.

5.1.1 Software Standards

The project is developed and managed in compliance with all the standard practices of software development to permit maintainability, scalability, and security. The development is modeled on the principle of modular coding, with an MVC (Model-View-Controller) inspired modular structure on the backend. The software also adheres to REST API in communication between the two ends resulting in consistent and predictable API response. Data validation is according to Zod schemas, which serve as a formula agreement between input and output consistency at a minimal error in the system. The authentication and authorization have been done according to the best practices and utilized JWT (JSON Web Tokens) and bcrypt to retain the safety of the passwords as per the safety norms of the users.

5.1.2 Hardware Standards

The BookNest platform is designed to be efficient to run on commonly available computing and mobile devices available in Bangladesh without the need for high-end hardware and for it to run smoothly and shine. The system runs on systems based on a personal computer, a laptop, and a smartphone and supports dual-core and ARM-based processors and at least 4 GB RAM for desktops/laptops and 2 GB RAM for mobile devices and at least 100 MB free space for cache of applications and local data. It supports common liability resolutions on screens and adaptive layouts for mobiles along with usage of internet connectivity via the protocol to enable an API or data synchronization without contactingly synchronization via an internet connection through the standard protocol. By using lightweight frameworks such as React.js [5] and Tailwind CSS [6], BookNest ensures that it relieves itself of resource wastage, promotes performance to users using devices with lower power, and also ensures that users can access the platform inclusively and effectively across various devices.

5.1.3 Communication Standards

The platform supports standard HTTP/HTTPS protocols of communication to facilitate secure and efficient transfer of communication data. It enables TLS encryption to safeguard sensitive information that include payment data and user credentials. On database communication, it implements MongoDB [4] drivers which comply with BSON standards. In addition, the platform will be optimized to be cross browser compatible with the standards of the World Wide Web Consortium to ensure consistency in access across platforms through mobile and desktop usage by the Bangladesh users.

5.2 Impact on Society, Environment and Sustainability

This section takes a look into how the proposed system would impact more on other fields other than just its technical implementation. It outlines the impacts the project has on the personal lives of the individuals, society and the environment in general, as well as its relations to ethical standards. Also, it highlights the sustainability strategy in order to make sure that the system will be effective, accountable, and effective in the future.

5.2.1 Impact on Life

The project has direct implications in the everyday life of the students, researchers, and the ordinary reader by making the purchasing of books less burdening and expensive to access. Rather than pay large amount of money to buy hard copies, one can borrow them, sell or trade them at a very small cost decreasing their financial burden. The system also eliminates physical dependency on libraries facilitating readers in going through a diversified range of books at any time and place.

5.2.2 Impact on Society & Environment

The societal impact revolves around reading culture development in Bangladesh, as the platform makes books and knowledge available and shareable in the society. The communities get an enhanced literacy level and increased mental engagement. The platform promotes resale and lending to others instead of buying the same book again and again, which decreases paper consumption indirectly making the environmentally-related impact of production of books smaller. Moreover, with locally based exchanges, little transportation is needed therefore cutting on carbon emissions. In this sense, therefore, the project generates a positive contribution not only to social development but also to environmental conservation.

5.2.3 Ethical Aspects

The system makes use of very strict ethical considerations Data privacy on user logs is secured with the use of authentication (JWT, bcrypt), so that unauthorized access does not happen. Ways to value Intellectual Property rights by avoiding illegal book exchanges and sales either by trespassing the Intellectual Property rights or by innovating illegal copies. The fairness of the platform is also guaranteed by equality between all the users of the platform who can purchase, sell, or lend books without any discrimination.

5.2.4 Sustainability Plan

The platform also applies a combination of strategies to its sustainability in the long term. The technical aspect is that it is based on the MERN stack which is broadly used and allows scalability. Modular architecture, in its turn, enables futuristic expansions, i.e. implementing subscription-based models or addressing digital libraries. Sustainability can be attained financially by small-per-transaction fee, premium features, or collaboration with publishing companies. Environmentally, the system has the ability to uphold a closed book cycle of books, i.e., reuse rather than waste. Socially, the platform seeks to develop a powerful user community to guarantee further significance and use. A combination of these things provides a good basis to work sustainably in the future.

5.3 Project Management and Financial Analysis

The platform has also been designed to be cost affordable and feasible considering it is a final-year project, with as much use as possible of open-source technologies and cloud-based resources to reduce costs. Agile methodology was used in managing the project, permitting the development, testing, and buying in phases and ensuring maximum utilization of the available resources. Time-boxing and task prioritization were used to focus on the main key functions including peer-to-peer books, distance-based search, and map-based location tracking.

The development was done with the MERN stack (MongoDB [4], Express.js [3], React [5], Node.js [2]), Tailwind CSS [6], and Framer Motion [44] to work with UI animations. I used VS Code as the main IDE, Node.js 20 to run on the backend and MongoDB [4] cloud database hosting. The testing was conducted on windows 11 laptops running On Chrome and Edge browsers, which shows the availability of the tools to students.

In keeping the cost low, open-source tools were used, and cloud instances were selected according to their free-tier or low-cost tiers which are favourable to students. They did not need a lot of hardware, including using regular laptops with a connection to the internet during the development and testing. There is no fancy infrastructure needed in the project therefore it can be adopted/replicated and maintained by students and the local users.

The project was planned such that no large start-up cost was required; however, there was the possibility of minor revenues being generated in the form of peer-to-peer loaning charges, resale commissions, and the option of more advanced features as summarized in Table 5.1, which provides a detailed breakdown of development costs, operational costs, and projected revenues.

Table 5.1: Project Cost and Financial Analysis

Category	Item/Activity	Estimated Cost (BDT)	Notes / Rationale
Development Costs	Frontend & Backend Development	20000-30000	If outsourced, free if self-developed
	Database & Cloud Setup	1500-2000 /month	MongoDB Atlas paid tier
	Google Maps API Integration	1500-2000 /month	Depends on request volume
	Clouinary for Image Uploads	1000 /month	Basic paid plan for images
	Testing & QA	5000-1000	If outsourced, negligible if self-tested
Operational Costs	Domain	1000 /year	Minimal cloud domain and cost
	Hosting	1500-3000 /month	Minimal hosting cost
	Payment Gateway Fees	1.5%-3% per transaction	Applied only when live
	Maintenance & Updates	5000-8000 /month	If a developer is hired, free if self-managed

	Marketing & Promotion	5,000 – 15,000 /month	Social media ads, promotions, branding
Revenue Streams	Lending Fees	5% BDT per book	Optional future implementation for P2P lending
	Resale Commission	5–10% per book	Optional future implementation
	Optional Premium Features	300–500 BDT/month	Can be added if project goes live commercially
Total Initial Investment	Development + Setup	30000-40000	One-time dev + Setup
Estimated Monthly Revenue	Lending & Premium Fees	15000–25000	Future, with adoption
Break-even Analysis	Time to recover investment	3–6 months	Depending on adoption and promotion

This financial plan demonstrates the possibility of still running BookNest, and to a manageable and sustainable degree, with paid services. The operational costs are still moderate, (hosting, database, APIs and maintenance) and the cost of developing is reasonable simplistic approach conducted compared to the potential revenue streams. The feasibility of implementation of the project is guaranteed by the combination of open-source technologies with cloud services that are cheaply available, and will be backed up by indication on a scalable hosting and professional-grade deployment. By adopting this approach, not only are the educational project requirements being met, BookNest also sees itself as a draft of the commercial viability of any project that might one day be incorporated into a platform for Bangladesh.

5.4 Complex Engineering Problem

The following section is the complex engineering issues that were experienced during the development of BookNest. It also reveals how these issues were projected on engineering problem-solving domains, knowledge ports, and engineering actions, in a show of the magnitude, interrelations and ingenious solutions that have to be attained in order to take the system on board.

5.4.1 Complex Problem Solving

The development of BookNest involved multiple challenges such as integrating peer-to-peer lending workflows, implementing distance-based filtering, real-time transaction tracking, and using APIs like Google Maps and Clouinary efficiently. Each of these challenges is mapped against seven engineering problem-solving (EP) categories in Table 5.2 to illustrate their complexity.

Table 5.2: Mapping with Complex Engineering Problem.

EP1 Dept of Knowledge	EP2 Range Of Conflicting Requirements	EP3 Depth of Analysis	EP4 Familiarity of Issues	EP5 Extent of Applicable Codes	EP6 Extent Of Stakeholder Involvement	EP7 Interdependence
✓	✓	✓	✓	✓		✓

EP1: This study demonstrates Depth of Knowledge applying full stack development (including designing a database, using grab API and mapping library) in building an integrated Peer-to-peer book sharing platform. Implementing distance-based filtering, map-based book placement, and in-the-moment tracking of transactions required a good understanding of React frontend, Node.js backend, MongoDB schemas and API integration.

EP2: The project had to be designed around several opposing requirements, including balancing high performance with a low API cost, seamless user experience and handling real-time data, and simple design vs. comprehensive function. Each decision needed to involve trade-off and optimization between competing constraints.

EP3: Depth of Analysis was based on an examination of user workflows, peer-to-peer transaction monitoring, and distance based search mechanisms. Various scenarios were experimented with to make sure that under different conditions the borrow workflow, free book section, and academic zone, which were experimented worked correctly, this is a systematic way of problem solving.

EP4: Although core components like React frontend and Node.js backend were strictly familiar knowledge before, How to integrate external services like Google Maps API and Cloudinary required us to do more research and problem solving in order to make sure that all these different modules will play together easily. Asynchronous data and API limitation handled offers practical exposure for less-documented issues.

EP5: The project used standard software practices in integration of the API and their security, with customized solutions for the peer-to-peer lending, distance filtering and map-based visualization. This translates to the pragmatic use of the engineering codes combined with innovative methodologies based on BookNest's specific needs.

EP7: The system modules borrowing workflow, distance filter, transaction log and map visualization are highly interdependent. Changes in one module have a direct influence on the others - requiring good coordination and integrated testing to ensure functional consistency across the platform.

Mapping with Knowledge Profile

The engineering problem-solving required integration of many bodies of knowledge, and this proficiency can be defined as the following knowledge profile, as summarized in Table 5.3. The table shows the mapping between the knowledge areas and their application within the BookNest system.

Table 5.3: Mapping with knowledge Profile.

K1	K2	K3	K4	K5	K6	K7	K8
Natural Science	Mathematics	Engineering Fundamentals	Specialist Knowledge	Engineering Design	Engineering Practice	Comprehension	Research Literature
✓	✓	✓	✓	✓	✓	✓	✓

K1: The project applied natural science and mathematics by using formulas like the Haversine equation to calculate distances between geo-locations. Computational concepts were also applied to ensure efficient data processing and reliable system performance.

K2: The project had to come up with algorithms, to be able to calculate distances between users and books, to optimize required search and filter operations and also to efficiently handle a huge data-set for the smooth working features in real time.

K3: Full-stack development practices were applied, including designing the React frontend, Node.js backend, and MongoDB database, alongside networking concepts and API integration to ensure seamless system communication.

K4: APIs of advanced usage, such as the use of Google Maps (to allow for location tracking) and Cloudinary (for media handling) as well as some logic to create a peer-to-peer book lending were needed to achieve core functionalities of BookNest.

K5: Designing diverse intuitive workflows for borrowing and returning books, implementing category filters and visualizing the books on maps turned out to be applied engineering design principles.

K6: UI /UX design principles were used to design a responsive and accessible interface with user interactions and platform usability in mind.

K7: Figuring out user requirements helped the platform to meet the needs of the diverse users such as registered users, administrators and peer borrowers.

K8: API documentation was reviewed and research into similar book sharing platforms helped to guide development decisions and the adoption of industry best practices.

5.4.2 Engineering Activities

Mapping of the engineering activities (EA) identified into the challenges and workflows required during BookNest development. Such activities included planning, design, implementation, integration, testing and evaluation.

Mapping with Complex Engineering Activities

The engineering of BookNest was the work of numerous development activities which covered the technical and the practical hurdles. These tasks involve laddering the architecture of the system, user interface design, core feature implementation, APIs integration, testing of the workflows and examining the performance, as summarized in Table 5.4. The table lists each of the activities and their related rationale, indicating the resources, interactions, innovations and societal impact as well as familiarity associated with each of the phases involved with the project. This mapping shows how each of the engineering activities can be used to address the complex problem of solving the problem of developing a localized and peer-to-peer book lending and borrowing system.

Table 5.4: Mapping with Complex Engineering Activities.

EA1 Range of re- sources	EA2 Level of Interaction	EA3 Innovation	EA4 Consequences for society and environment	EA5 Familiarity
✓	✓	✓	✓	✓

EA1: The development of BookNest drew on many different resources which were used to keep the cost down and maximise efficiency. The MERN stack (MongoDB [4], Express.js [3], React [5], Node.js [2]) gave an open source, end-to-end stack used. Free-tier APIs like geolocation with Google Maps and media management with Cloudinary were used. The developed and tested devices were used for individual personal drawback, and free hosting platforms provided use, so that the set would be cost-effective even when it can be fully operational.

EA2: BookNest demanded real interaction in between system parts. Front-end interfaces communicated with the back-end in a dynamic way by sending API requests and database queries. Real-time updates ensured that changes such as the available books, the status of loans, and information about location were reflected to all users right away. This constant interaction required careful design and testing in order to achieve this consistency and performance.

EA3: The project included a number of new features tailored to the context: Distance-based filtering enabled a user to discover nearby books in an efficient manner and the use

of maps added visuality of available books. The organized process of peer-to-peer loaning simplified the process of obtaining a loan and making a loan repayment, decreasing stiffness in user interactions. These innovations satisfied the practical requirements of the user while making user experience intuitive and entertaining.

EA4: There is positive social and environmental implication in BookNest. By encouraging the reuse of physical books the platform takes out the demand for new printing leading to reduced environmental impact. It promotes community engagement by linking local readers and gathers digital access to ensure inclusivity to those who don't have access to physical libraries. These are the aspects that emphasize the sustainable design philosophy of the platform.

EA5: While developers were familear with core technologies such as React [5] and Node.js [2], advanced functionality such as API integration (Google Maps, Clouinary) and geolocation based logic, needed to be learned and problem solved. This balance of what we already know and unfamiliar territory allowed a great level of efficiency in both development and the improvement of skills which resulted in a quality, working platform.

5.5 Summary

This chapter outlines the engineering requirements, design issues and sophisticated problem-solving encountered as BookNest was developed. It defines how software, hardware and communication standards must be followed to support maintainability and security, interoperability and usability. The effect of the project on the society, environment and ethics is discussed, noting the positive changes in accessibility, literate culture, re-usable books and fair usage of resources. Financial and project management study reveals the system was designed on a low budget by utilizing free or cheap materials, open-source code and cloud sources allowing it to be designed as a student project in final year yet retaining the possibility of revenue generation when fully implemented. Complex engineering problems were found in three areas: including peer-to-peer workflows, distance-based filtering and real-time transaction, and API integration among others, positioned alongside engineering problem category, knowledge profile, and activities. As demonstrated in the chapter, effective planning, the use of modular design, optimization of resources, and creative engineering efforts allowed the development of a viable, sustainable, and locally applicable peer to peer book lending system.

Chapter 6

Conclusion

This chapter wraps up the discussion on this development and implementation of BookNest by giving concluding remarks on the project accomplishments, limitations of the project and some possible future de-limitation steps. It documents the aspects of how the project goals have been met and how the system can be further advanced to focus on the further requirements of peer to peer sharing of books and localised circulation of books.

6.1 Summary

BookNest is a successful implementation of an absolute peer-to-peer book lending and borrowing and resale service with a priority on usability, accessibility and local applicability in Bangladesh. These fundamental features include user registration, book upload, borrowing requests, distance-based filtering and map-based book location whose implementation consists of free or low-cost packages like the MERN stack, the Google Maps API and the Cloudinary. Testing revealed that all features are functional and have the capability of updating in real time. The project illustrates the sustainability feature, promoting the physical book reuse, minimizing the environmental . It is also convenient and cost effective, scalable model which can be implemented at student level with future expansion.

6.2 Limitation

- i. BookNest is not designed to make strong recommendation settings such as personal tips or favorites.
- ii. Borrowers and lenders do not receive the real-time notifications fully automated.
- iii. Integration of payment gateway is available in sandbox or trial mode only; not capable of performing transactions.
- iv. The platform is optimized to use by web users but not yet is a dedicated mobile application.
- v. There are limited free-tier API limits (Google Maps, Cloudinary) and this may curtail massive usage without the paid solutions.

6.3 Future Work

- i. Implement personal recommendation system and the favorites functionality to provide better user experience.
- ii. Come up with a mobile application to enable more access and adoption.

- iii. Integrate comprehensive payment gateway integration to ease peer to peer payment processing and optional high end services.
- iv. Include an administration panel that would make it easier to manage, analyze, and control user actions and book distribution.
- v. Make it a subscription-based platform or introduce a system of microtransactions to develop a revenue stream and still maintain the platform.
- vi. Expand Adoption with external libraries or educational organizations in order to scale the books and partnerships.
- vii. Have an excellent push notification and real-time messaging to communicate efficiently between lenders and borrowers.

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