

Next-Generation Virtual Library

A MINI PROJECT REPORT FOR THE COURSE DESIGN THINKING

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II YEAR B.E Computer Science and Engineering



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ABSTRACT

The Next-generation virtual library project is a novel effort to digitize and simplify the old library system in mobile first and user-centric platform. Conceived with the use of Flutter for the front-end and Firebase for backend services, the system provides a convenient, scalable and efficient mechanism of managing and retrieving academic materials. The platform is based on the role-based access control and provides students, instructors, and administrators with the possibility to interact with the system within the scope of their needs. Important features are category-wise book organization, real-time updates, secure login, a seamless integration with a payment gateway for advanced functionalities like the book rental or access to premium content.

This system predisposes solutions to fundamental shortcomings of traditional library systems like limited operating hours, the absence of organization, no coverage to remote users, and cumbersome administrative activities. Through assigned book-listings (for instances CSE, EEE, Core Subjects, and Project Reports), intuitive searching and sorting options, real-time content handling, the platform is facilitating increased user satisfaction and educational effectiveness.

The use of Firebase ensures secure and real-time synchronization of data while cross-platform abilities of Flutter provide consistent experiences on both Android and iOS devices. The design took the form of the Design Thinking approach, placing a key focus on empathy with a user, iterative prototyping, and continuous feedback to make sure the final product serves the actual world needs in studies.

In ‘gathered’ insights from students, instructors, and administrative staff, knowledge of the design of user-friendly interfaces, and the orientation of the platform towards various roles in an academic ecosystem. Finally, the Next-generation virtual library rethinks the public access to the educational resources for the digital age, making them more accessible, manageable and interactive. Future versions of the project plan on adding such functionalities as AI-based recommendations, notification system, analytics dashboards, and theme customization options, expanding the project’s applicability in wider educational environments.

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1. Introduction

Nowadays, with the digital world still moving forward, people's patterns of searching for and interacting with educational content have changed considerably. What was once confined to bricks and mortar buildings with limited access to knowledge is now transforming into adaptable, digital libraries for the internet. The shift towards digital platforms is less a transition of placing books on the internet and more a reconfiguration in the way the interface used by the user is approached to make it a way to have a continuous, personalized experience based around end-users. The adoption of virtual libraries facilitate the access by students, lecturers, and administrators to get academic books, research articles and other learnings material at will from a distance.

While making digital resources available is not that far, it does not go far enough. To design worthy digital interactions, we need to understand our audience's wants, difficulties, and habits wholly. DST is essential, for this use. The methodology emphasizes understanding users, creatively approaching the issue, and improving ideas through iterations so that the output product will effectively involve users. Design Thinking steers teams out of an immediate conception and pushes them towards exploring the perspectives of users, uncovering real issues, and conjuring action-albeitable, user-based fixes.

This project report provides a brief summary of the conceptualization and development of the Virtual Library, which is a user centered, up to date and interactive solution for academic institutions. Using this platform affords students intuitive navigation, allows for instructors to organize and suggest content, and simplifies operational control for administrators. During the entire development path including all brainstorming meetings and introduction of usable functionalities, our endeavour was focused on the core practices of Design Thinking. In keeping our line of work on a focus to deliver the features that actually count, we developed the Virtual Library as a useful and assertive learning tool, and not just a piece of digital computer equipment.

1.1 Design Thinking Approach

Design Thinking uses creativity and team work in tackling complex issues while prioritising the needs of the user. It encourages organizations and their project teams to adopt users as their focus by using empathy, experimenting, and constantly modifying their solutions.

The fundamental idea of the Design Thinking is that actual users' insights dictate the development of productive solutions, and the best solutions are those that are constantly adapted and iteratively improved.

Key Characteristics of Design Thinking:

- Human-centered: Makes user experience the central issue in the process.
 - Collaborative: Involves stakeholders from different backgrounds.
 - Iterative: Holds over using a great deal of adjustments after each user feedback is obtained.
 - Experimental: Welcomes risk-taking and non-linear progress.
- Types of Design Thinking Models

There are several frameworks for applying design thinking, each tailored to specific domains. While they share common principles — empathy, ideation, and experimentation — they differ in structure and terminology

1. Stanford Design Thinking Model

- Developed by the Hasso Plattner Institute of Design at Stanford University (d.school), this model is widely recognized in educational and technological innovation.
- It is a five-phase model that encourages non-linear movement between phases to explore and refine ideas thoroughly.

2. The Double Diamond Model

- This model was created with the support of the UK Design Council and is aimed at the combination of divergent and convergent thinking. It includes four phases:
 1. Discover (Explore the problem)
 2. Define (Specify the problem as close to practical application as possible).
 3. Develop (Create solutions)
 4. Deliver (Apply and assess the most effective solution).

3. IDEO's Design Thinking Model

- A three-phase model developed by IDEO, a leading global design company. The stages are:
 1. *Inspiration* – Understanding the challenge and observing users
 2. *Ideation* – Brainstorming and developing concepts
 3. *Implementation* – Turning ideas into real-world solutions

1.2 Stanford Design Thinking Model and Its Phases

The **Stanford Design Thinking Model** offers a structured yet flexible framework for driving innovation through a deep understanding of user needs. Comprising five iterative stages — *Empathize*, *Define*, *Ideate*, *Prototype*, and *Test* — the model empowers project teams to explore challenges from a human-centered perspective and arrive at creative, practical solutions. Unlike linear development approaches, this model encourages cycling back and forth between stages, allowing teams to continually refine and improve their ideas. This iterative nature is especially valuable in projects like the **Virtual Library**, where user feedback and real-world interactions shape the evolution of the platform. By embracing this model, our team remained agile and focused on delivering a solution that truly addresses the academic and operational needs of our users..

Phases of design thinking models:

1. Empathize

Purpose: To deeply understand users by immersing in their experiences, environments, and emotions.

Techniques Used:

- Direct user interviews and discussions
- Shadowing or observation of daily library interactions
- Empathy mapping to visualize user thoughts, feelings, and behaviors

Outcome: A clear emotional and practical understanding of user needs, frustrations, and expectations, forming the foundation for all subsequent stages.

2. Define

Purpose: To incorporate Empathize phase research and formulate a precise, real problem statement.

Focus: Build a Point of View (POV) that reflects ambitions, motivations, and the problem of the user.

Outcome: A workable problem statement that guides the creation of ideas.

Example POV: “Students must be constantly able to access academic materials because traditional libraries have limited hours and materials”.

3. Ideate

Purpose: To discuss the wide range of innovative solutions without any restrictions and criticism.

Techniques Used:

- Brainstorming sessions for idea generation
- Use of mind mapping for identifying relations between different features;
- Re-imagining old systems with the help of SCAMPER techniques: Substitute, Combine, Adapt, Modify, Put To Another Use, Eliminate, and Reverse.

Outcome: Diverse innovative ideas are generated and the practically and meaningfully applied ideas are ranked for priority.

4. Prototype

Purpose: To offer stakeholders' concrete iterations of ideas that they can experience and analyze.

Types of Prototypes:

- Cross-sectional views of page layouts designed by physical tools.
- Visual digital representations of main product screens such as dashboards and category views, etc.
- Role-play scenarios simulating user interactions

Outcome: The prototype to be shown to the product design in order to allow users to test and provide valuable feedback.

5. Test

Purpose: In order to evaluate the usability and validity of design decisions, by observing users' behavior during their interaction with prototypes.

Process:

- Implementation of the prototype to sample representatives of various groups, students, instructors and administrators.
- Obtaining user responses and testing the degree of ease with which the prototype can be used.
- Watching on patterns of behavior to determine those that reveal successful features and those that need changing.

Outcome: Valuable learnings to propel necessary updates and to make the final version more considerate of the user needs.

2.Literature Review

Araya et al. [1] proposed a web-based library system that highlights how such platforms improve accessibility by allowing users to access library resources from any location. The authors argued that web-based systems not only enhance accessibility but also scale effectively, providing a platform for real-time collaboration and resource sharing.

Singh et al. [2] conducted a comparative study on two widely used open-source library management systems, Koha and NewGenLib. Their research underscored the advantages of open-source systems, particularly their affordability, flexibility, and customization capabilities, which allow libraries to tailor systems to their specific needs without significant financial investment.

Kumar et al. [3] analyzed the management of library resources in universities, focusing on cataloging, search functionality, and user management. Their study highlighted essential features required for an efficient LMS, emphasizing the importance of seamless access to digital content in academic environments.

Abdulrazaq et al. [4] discussed the design and implementation of an online library system that incorporated online book requests, digital catalogs, and an admin dashboard. Their work demonstrated how digital systems could simplify library operations, providing a more efficient experience for both users and administrators.

Archana et al. [5] evaluated the catalog interfaces of integrated library management systems (ILMS), comparing proprietary and open-source software. Gibbons et al. [6] introduced the concept of integrating library resources with course management systems (CMS). By doing so, students could access academic content directly from their learning platforms, thereby streamlining the process of retrieving educational materials.

Chouhan et al. [7] highlighted the growing role of open-source software (OSS) in library management, arguing that OSS allows libraries to adapt and innovate without incurring high costs. This flexibility is particularly beneficial for institutions with limited budgets, as it provides a way to customize systems to meet specific needs.

Rafols et al. [8] explored the use of "science overlay maps," a tool that helps manage research information and improve library resource distribution.

Li et al. [9] proposed the use of Internet of Things (IoT) technology for automating aspects of library management. With the integration of smart shelves and real-time tracking, IoT could revolutionize how resources are managed and accessed in libraries, creating a more efficient and user-friendly system.

Țundrea et al. [10] examined the potential of artificial intelligence (AI) in library systems. They highlighted how AI could automate cataloging, offer personalized content recommendations, and improve administrative efficiency.

It is clear from literature that future progress on library management hangs heavily on the integration of advanced and new technologies. The adoption of the open-source software, cloud platforms, IoT, and AI into Library Management Systems is provoking redefinitions on both technology as well as user interaction with academic resource.

3. Domain Area

3.1 Overview of the Domain

This initiative flourishes at the crossing point between Library Science, Information Technology, and Educational Technology and it aspires to contribute constructively as to the development of modern digital educational environments. Although primary repositories of knowledge, traditional libraries are often plagued with problems such as restricted physical access, manual resource handling, lack of scalability, and availability. Such constraints can hinder learner's capacity to access educational material in a timely manner, especially if those are remote or have limited access hours.

Digital Libraries which are commonly referred to as Virtual Libraries have brought across a much needed paradigm to address these problems. Advanced integration of web technologies and cloud services provides the Virtual Library systems with unrestricted access to academic resources, day and night, irrespective of geographic sets of restrictions and time constraints. Moreover, these systems help to create better access to education, but they also maintain security, organization, and scalability in their conduct.

This project is consistent with and assists many fields of technology and education:

- **E-Learning Platforms** – Creating learning opportunities from remote to hybrid based on the inclusion of academic resources in their virtual learning environments.
- **Digital Content Management Systems (CMS)** – Facilitating the order-collecting and distribution of educational content.
- **Cloud Storage** - Services in addition to Real-time Databases for efficient use of the big data for storage and synchronization of the content.

3.2 Key Characteristics of the Domain

1. Digital Resource Management

At the heart of the Virtual Library's operation is an 'electronic asset management' platform which is sophisticated in nature and aimed at storing, classifying, identifying, and passing educational materials in several formats. eBooks (like PDF and EPUB)

Core Functionalities:

- **Metadata Tagging:** Each resource has metadata such as title, author, department affiliation, academic level and file type attached to it, having a well-organized manner of data storage.
- **Advanced Search and Filtering:** As a result of enhanced searching abilities, it is easy for a user to identify resources in a short time using keyword, department, author, or category.

2. User Role Management

In order to ensure that students, faculty, and administrative staff get a full experience, the system uses a secure Role-Based Access Control (RBAC) framework. Thus, the system provides a standards-compliant interface to each user so that he/she can execute tasks he/she is authorized to accomplish because of his/her role.

User Roles and Capabilities:

Students:

- Browse categorized materials
- Use keyword search and filters

Administrators:

- Manage user accounts (add/remove/edit roles)
- Verify that the material under load conforms to expectation of quality.

3. Accessibility and Usability

Modern learning platforms need to focus on wide access and ease of use on any devices. Key principles applied include:

- Flexible design that maximizes PC, tablet, and smartphone appearance and functionality
- Make navigation menus unimportant so that it is efficient and easy to access learning materials.
- Design options such as scalable fonts and high-contrast modes give the users extra accessibility options.

4. Cloud Integration

Cloud solutions with Firebase among others offer core benefits which include:

- Real-time content updates and synchronization
- Secure, scalable data storage
- Smooth automatic backup processes and almost zero downtime windows.

With the help of cloud integration the library can timely stay updated, accessible at all times, and manage a massive number of users efficiently.

5. Security and Authentication

Due to the extreme academic and intellectual value of the content, it is essential to put major security measures into place with regard to the Virtual Library system. To protect user details and educational resources the platform relies on the complex security system.

3.3 Real-World Applications of the Domain

Virtual Library systems employ principles and technologies that have wide applicability in many other fields

1. University and College Digital Libraries

A growing number of schools and universities are adopting digital libraries in order to allow the students and the faculty to access academic materials with ease. Examples include:

- Shodhganga (INFLIBNET's Indian thesis repository)
- National Digital Library of India (NDLI, or Digital India Library)

Our approach provides a similar access to organized academic materials any time like these systems.

2. Corporate Learning Management Systems (LMS)

Organizations leverage digital libraries for:

- Hosting training materials
- Distributing onboarding manuals

3. Online Research Repositories

It is for this reason that scholars use resources such as arXiv, ResearchGate and SSRN to share their research and project reports. Our system enables users to share and search categorized reports and publications, which offers resemblant features to academic repositories like ResearchGate and SSRN.

4. Empathize Stage

It is the empathize activity at the root of the Design Thinking methodology that aspires to gain deep insight into users' behaviors, needs, motivations, and points of frustration. This empathetic process teaches designers and developers not to lean on assumptions and listen to their choice on insightful data obtained from users. To design the Virtual Library project, it was important to know our users' needs in order to build a system that meets functional, accessible, and role specific needs.

4.1 Activities Conducted

Attempt to get a comprehensive understanding of user expectations and challenges involved: steering structured design research activities:

● Stakeholder Mapping

Journey started in 2010 and afterward carried through early years of the project.

- Students (Primary Users): Look for simple and convenient sources of academic materials.
- Administrative Staff: Set responsibility for using information, controlling access to the library, and protect the system as a whole.

This activity allowed us to identify the workflows of the users and to concentrate on developing features tailored to their unique duties.

● Empathy Mapping

We used empathy maps to understand user experiences better:

- What users say: 'I'm not able to find the book I need'.
- What users think: Access to each course material in one place would be of great benefit.
- What users do: Periodically search using web searches, or request physical PDF copies from friends.

Through this approach, we were able to identify hidden user requirements that would have been overlooked following a simple hold up.

4.2 Literature Reviewed

The literature reviewed the latest trends and challenges of introducing digital libraries in Indian higher learning institutions. Literature that seeks to explore the way students use digital libraries and measure the impact of digital materials on their academics.

4.3 Primary Research

To gather firsthand user feedback, we adopted a mixed-method approach:

● **Observational Research**

To observe student behavior in physical libraries we identified the following:

- Borrowing patterns
- Frequent complaints

Sample Questions Asked:

Which features in Virtual Library are most in need for you?

Sample Responses:

- "Sometimes we are unable to locate the texts needed for our subjects.
- It's difficult to access project reports since they at times are not easy to find or are sometimes only available offline.

Conclusion of the Empathize Stage

The Empathize stage was the basis behind the use of the design thinking methodology used in the generation of the Virtual Library. This phase was important in determining the project's direction, as it ported the focus on building a profound understanding of the target users, which are, in this case, students, faculty members, and library administrators and so on, and how they interact with digital library systems. In this stage, our aim was to establish their needs, common pain points, their behavior patterns, and observe them undertaking daily activities on accessing, managing, and using library resources.

To do so, we integrated a multi-faceted user research strategy that included a set of qualitative and quantitative methods. These were as follows: in-depth interviews, direct observations, spontaneous conversations, and structured surveys. Each of these techniques was selected to help to acquire honest feedback of the users and uncover some insights that can not be discovered with more conventional requirements gathering processes. From these, we were then able to see overlapping themes and regularities in expectations and practices from users. By orienting the designs around these user realities, the Virtual Library was transformed into a system that not only satisfies functionality but also makes it resonating with the practical and emotional needs of its culturally and socially diverse audience.

5. Define Stage

This reveals a critical juncture in the Define stage for Design Thinking as Empathize— phasis findings are synthesized to create a well-defined statement of problem. The Define stage is responsible for bringing the project goals and user needs together tightly by translating observations into practical phrase statements for problems.

In the case of the Virtual Library system, this was a very important step for turning user challenges into valuable opportunities for formulating solutions. It helped the group to prioritize and specify the most important user needs, and determine a joint goal for system construction.

5.1 Analysis of User Needs

Table1 explains the analysis of user needs,based on close observation, in-depth interviews, survey respondents and secondary research, a set of vital user requirements emerged. These needs generated what the users needed in terms of functionality as well as what they desired, emotionally as students, instructors and administrators of this platform: students, instructors, and administrators. These user needs were recurring across various interviews and surveys and became the foundation for identifying design challenge.

| User Group | Key Needs Identified |
|------------|---|
| Students | <ul style="list-style-type: none">- Easy access to categorized books and materials- Instant download/viewing of resources- Efficient search by author, department, or subject |
| Admins | <ul style="list-style-type: none">- Ability to verify user roles and content- Control over categories and resource types- Monitor user activity and access levels |

Table 1: Analysis of user needs

5.2 Identified Problem Statements

Problem Statement 1: Student Perspective

An overview platform that will be helpful to students searching and using categorized academic resources is necessary because lack of easy access to libraries and improperly organized digital tools makes it hard to shift.

Problem Statement 2: Administrator Perspective

An overview platform that will be helpful to students searching and using categorized academic resources is necessary because lack of easy access to libraries and improperly organized digital tools makes it hard to shift.

5.3 Solution

To address these interlocking problems, the team came up with the detailed problem statement reflecting all stakeholders' opinions:

- One interface accessible for students, instructors and admins, featuring roles specific functionality.
- A scheme of content arrangement using tags and metadata which makes it more simple to navigate and access certain items.
- Forcing secure permission based interactions using Role-Based Access Control (RBAC).
- An easy to use interface which enables individuals with no technical knowledge to easily upload, browse and manage resources.
- Excellent learning resources continually accessible to learners in any place through cloud-based infrastructure.

This solution makes it easy and fast for students to access learning resources; an easy teaching experience for instructors; and administrators are given tools for a secure, scalable learning environment.

6. Ideation Stage

The Ideation stage played a critical role in the development of the *Virtual Library*, acting as a catalyst for the generation of diverse, creative, and user-centered solutions. Building upon the insights gathered during the Empathize and Define phases, the team entered this stage with a well-rounded understanding of user needs, behaviors, and challenges. Armed with these insights, the focus shifted toward creatively addressing the identified problems through collaborative brainstorming and ideation techniques.

Team members participated in collaborative ideation sessions designed to foster openness, creativity, and inclusive dialogue. These sessions emphasized a team culture that valued originality, divergent thinking, and non-judgmental evaluation of all contributions—whether conventional or unconventional. The goal was to create an environment where every idea could spark further innovation, regardless of its initial feasibility.

By the end of the Ideation phase, the team had not only generated a diverse range of innovative ideas but had also begun refining and selecting those most aligned with both user expectations and practical implementation. This structured, user-driven ideation process laid a strong foundation for the Prototype and Test phases that followed.

6.1 Mind Mapping

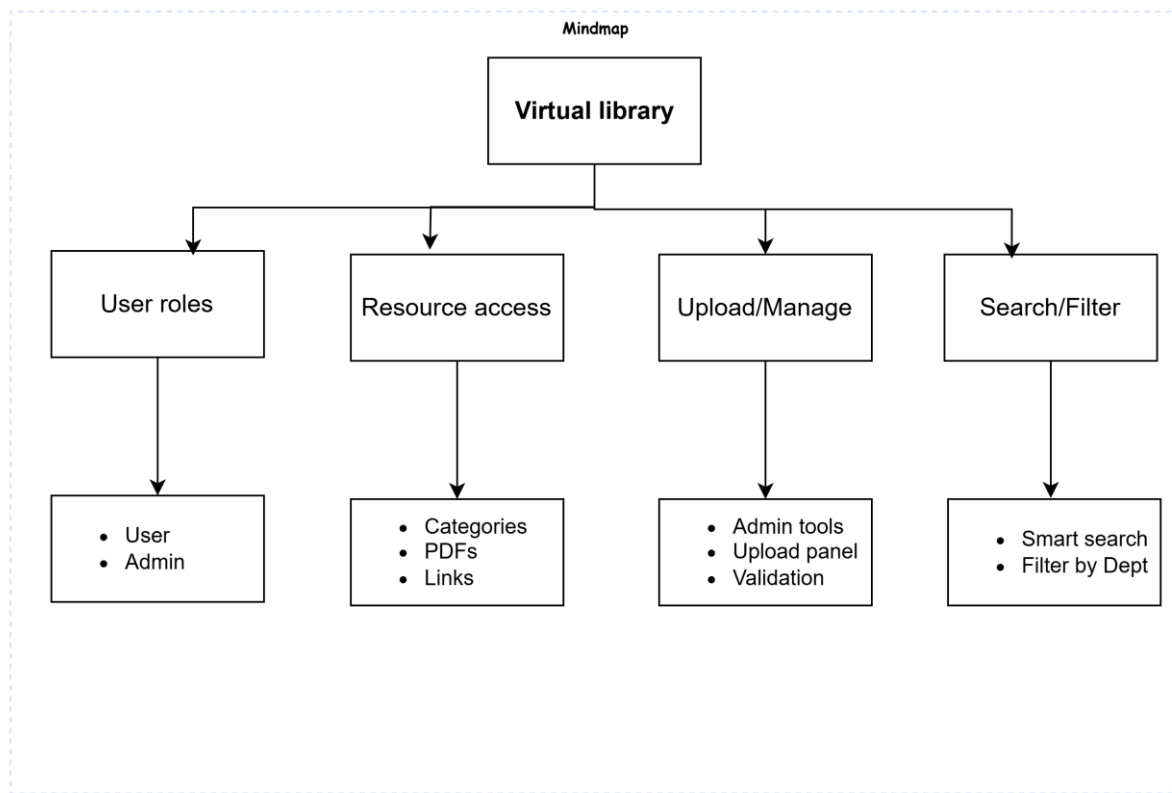


Figure 1: Mind map

Figure 1 says that , The visual diagram shows the larger components of the Virtual Library system, including four critical functions: User Roles, Resource Management, Upload / Manage and Search / Filter. The User Roles section distinguishes ordinary users (students and instructors) and administrators, so that each user has the required access rights. Resource Access makes it possible for users attempting to access organized academic resources including PDFs and external links in a simple manner, thus allowing the smooth access to relevant information. The Administrators use the Upload/Manage module to manage material uploads, validate the edits, and manage the quality of the content efficiently because of its panel-oriented design. Equipping users with strong searches and department-specific filters allows the Search/Filter enhancement to focus the discovery of a library's asset on the platform. Such features ensure that there is a user-friendly, secure work station that provides 24 hour access to educational resources for users. By promoting collaboration and creativity, the Ideation phase helped the team to start anew and design a digital library that promises usability with state-of-the-art technology.

6.2 System architecture

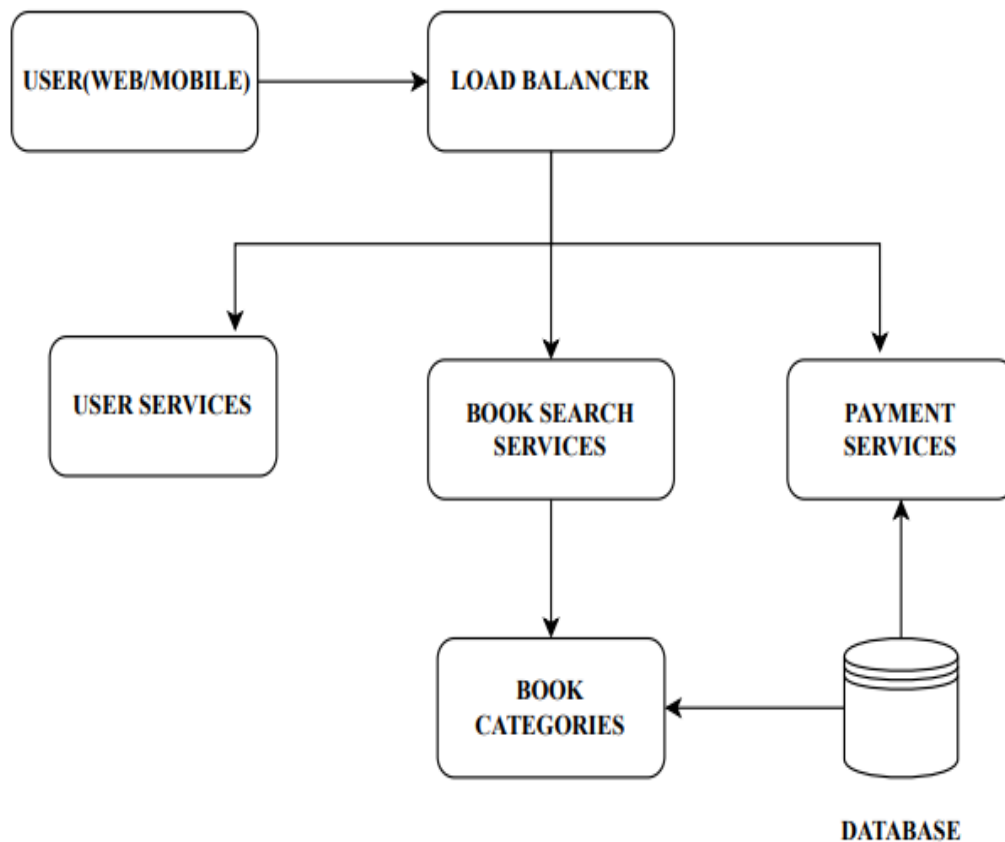


Figure2: System Architecture

Figure2 says that, The design of the Virtual Library uses a modern client-server architecture which aims at providing scalability, responsivity and effortless operation across many systems. The client element of the system is based on Flutter, Google's open-source UI tool kit, which enables fast and efficient mobile applications that run on the same terms across both iOS and Android devices and are built from a single code base. Flutter utilizes widgets in order to design an interesting and real-time user interface to enable both the normal and administrative teams to have a smooth experience.

The infrastructure on the server-side of the application is based on the use of Google Firebase, which implements a complete Backend-as-a-Service solution. Firebase Authentication offers secure functions for login and sign-up as well as services for users to select a range of authentication choices. Cloud Firestore is a NoSQL cloud database used to store and list structured data related to the user profile, e-book metadata, physical book inventory, categories and authors.

6.3 Brainstorming Session: Solution Ideas

After collaborative discussions, the team generated four primary solution ideas targeting the challenged highlighted in the problem statement that include:

1.Role-Based Virtual Library Platform

- Different student and instructor dashboards are used for students, instructors, and admins with different levels of access.
- Sorted educational materials for each department and type of resource.

2.Dynamic Category System for Upload and Categorization of Content

- Admins are able to create, modify and manage category structures.
- Instructors can load educational content to the adequate categories.

3.Smart Search and Filter System

- Users can search for resources by book title, author, department, or custom tags.
- Adding live suggestions and auto-completes to make it easier for users to make use of the platform.

4.User-friendly interface on Smartphone and Tablets, Offline Download available.

- Dynamic site structure which is compatible with mobile meaning, tablets and desktops without issue.
- Offline access to materials for reliable use even without connected internet.

6.4 Value Proposition Statement

Students, faculty members, and academic administrators, for that matter,

Experts manage this platform, the Virtual Library, with resources and role specific differences within a community for appropriate management and distribution of educational content.

With a user centric perspective, the Virtual Library promotes academic productivity, offers accessibility to resources as well as promotes constant involvement.

7. Prototype Stage

During the Prototype, stage the emphasis is on the manufacture of material models or mockups based on the concept generated during Ideation. The idea is to quickly analyse how the interface, layout, and key features interact before starting major development.

7.1 Welcome page:

Figure3 illustrates the welcome page ,entry point of users, giving access to login or register.



Figure 3: Welcome page

7.2 Register page:

Figure 4 illustrates the register page which allows users to create an account based on their role: Student, Instructor, or Admin.

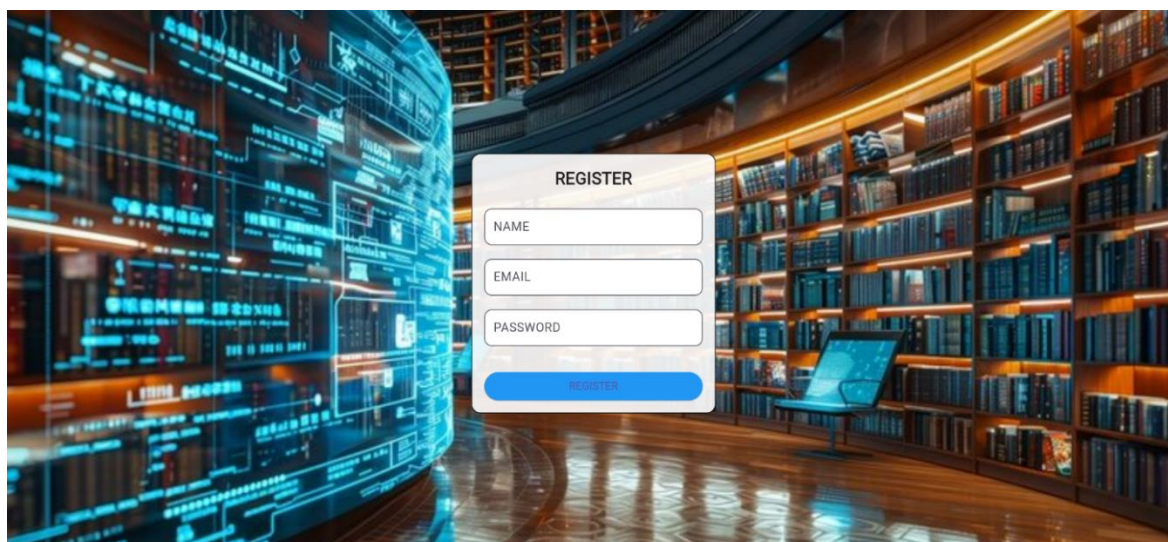


Figure 4: Register page

7.3 Login page:

Figure 5 illustrates the login page, which provides Role-based login with validation and redirection to respective dashboards.

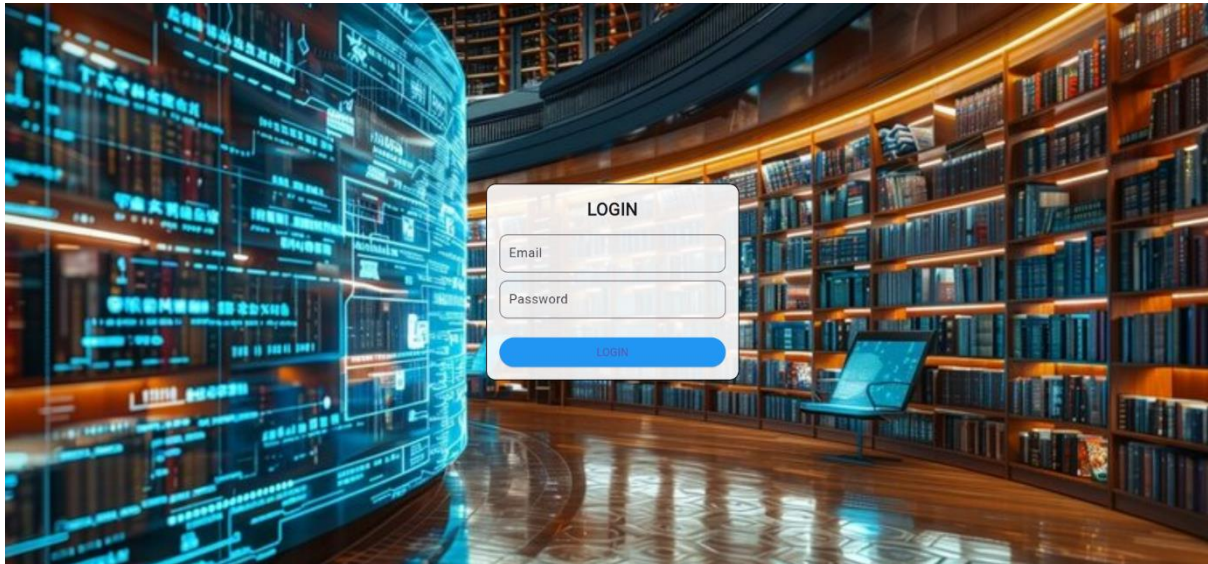


Figure 5: Login page

7.4 Admin dashboard:

Figure 6 illustrates the admin dashboard, Admin can manage book categories, verify uploads, and view analytics.

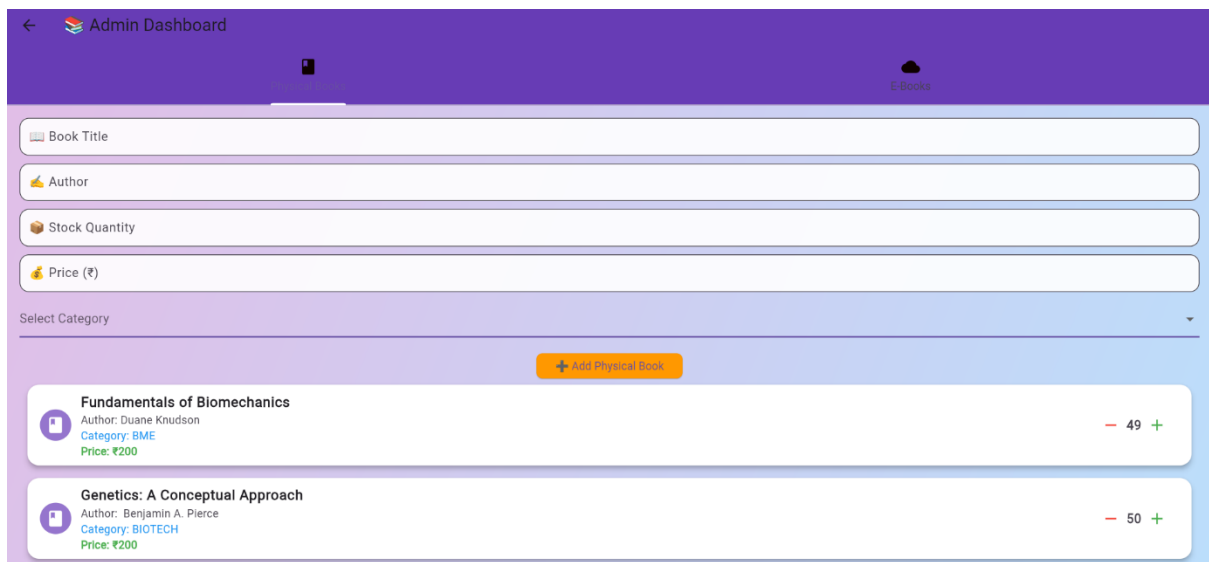


Figure 6: Admin dashboard

7.5 Home page:

Figure 7 illustrates the Home page, it displays categories like CSE Books, EEE Books, Core Subjects, and Project Reports.



Figure 7: Home page

7.6 E-books page:

Figure 8 illustrates the E-Books page which lists available e-books with titles, authors, availability, and download options.

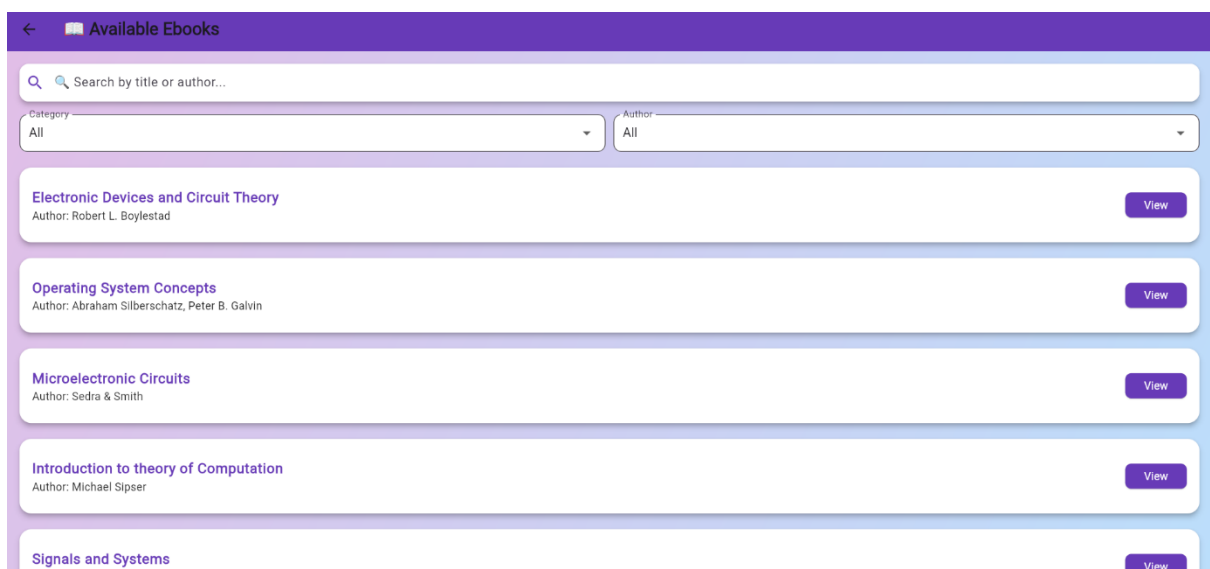


Figure 8: E-books page

7.7 E-Books-Author filter:

Figure 9 illustrates the search functionality to filter e-books by author name.

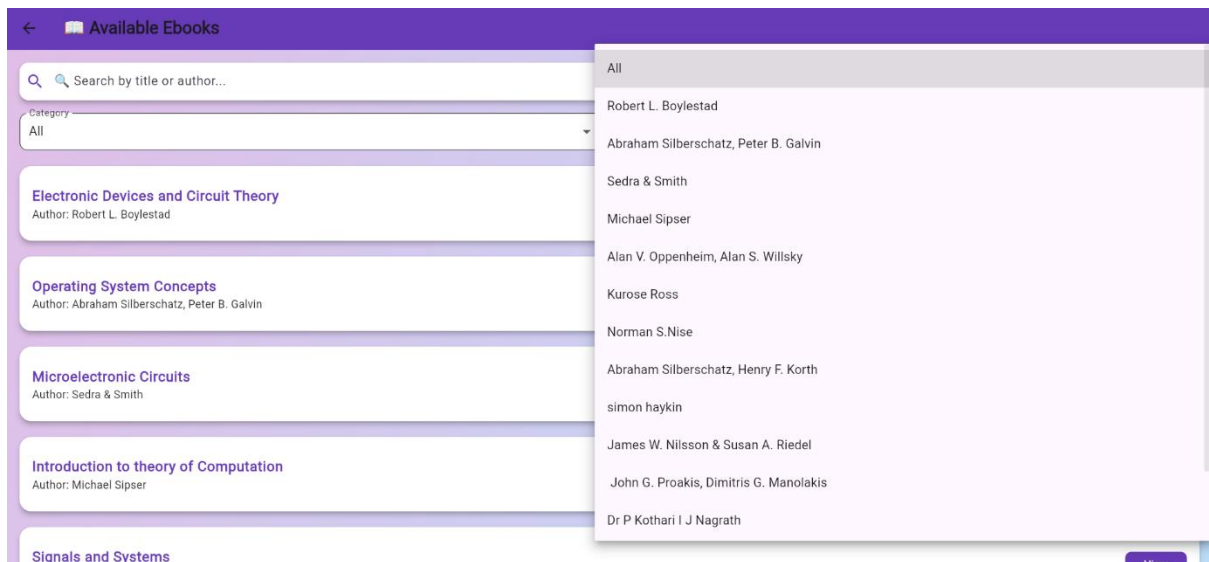


Figure 9: E-Books-Author filter

7.8 Category filter:

Figure 10 illustrates the functionality to filter books by subject or department categories.

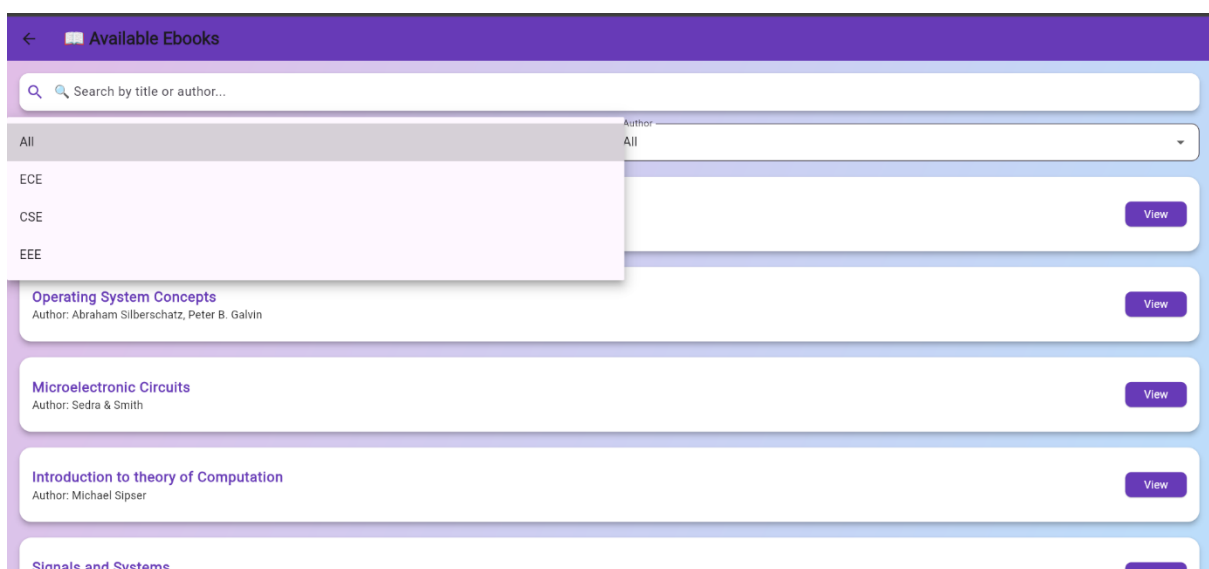


Figure 10: Category filter

7.9 Books page:

Figure 11 illustrates the books page which provides a detailed view of individual book listings with metadata and actions (borrow/download).

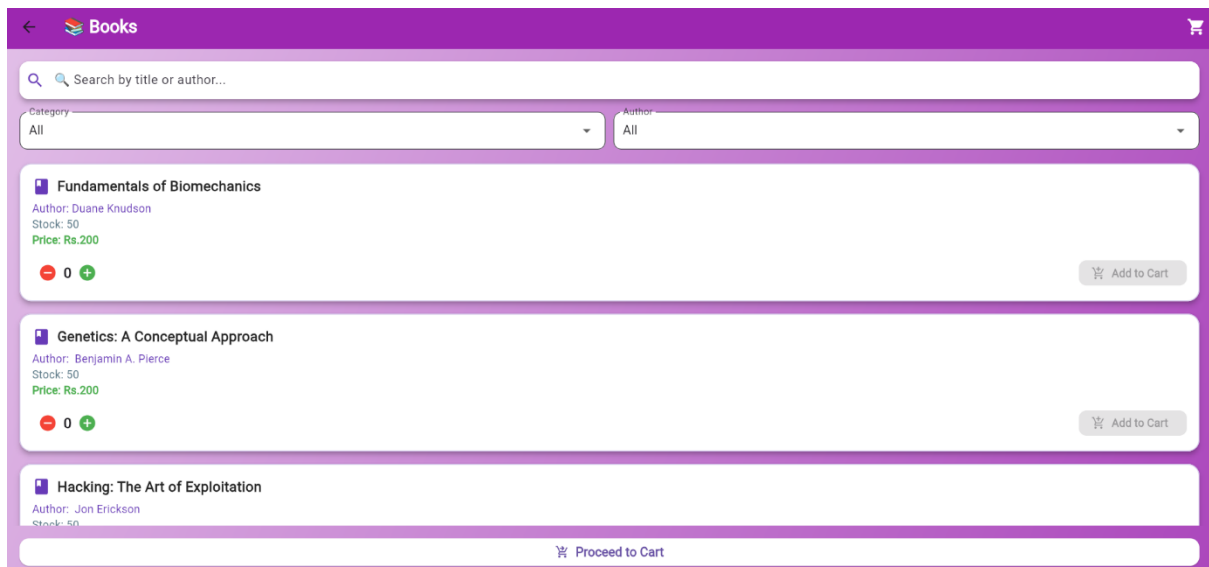


Figure 11: Books page

7.10 Books-Author filter:

Figure 12 illustrates the functionality to filter books by author name.

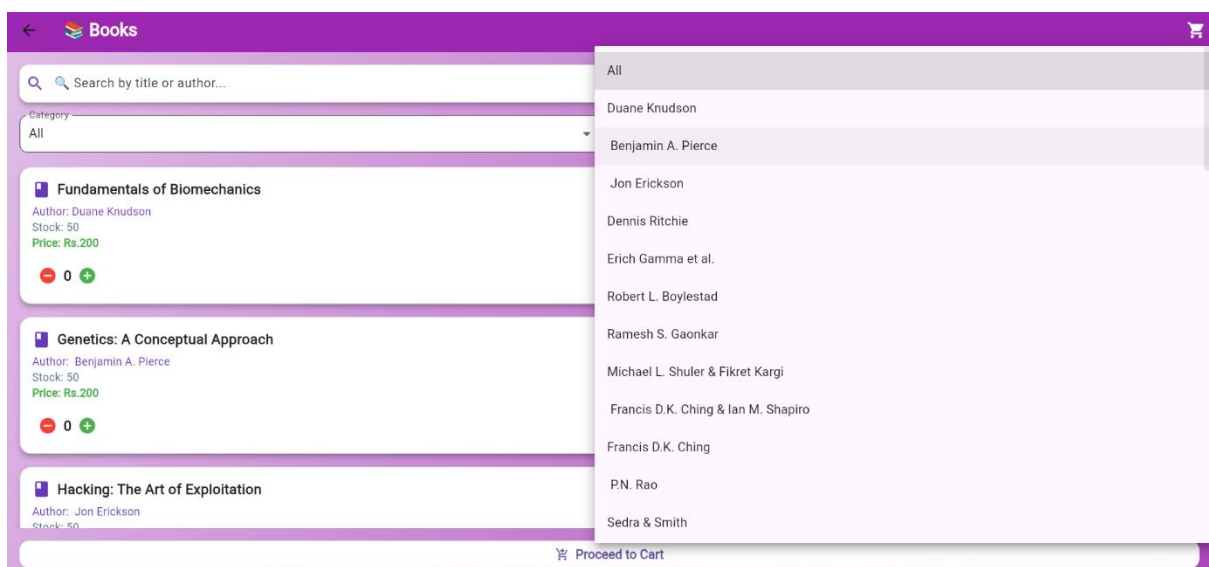


Figure 12: Books-Author filter

7.11 Department filter:

Figure 13 illustrates the functionality to filter by departments.

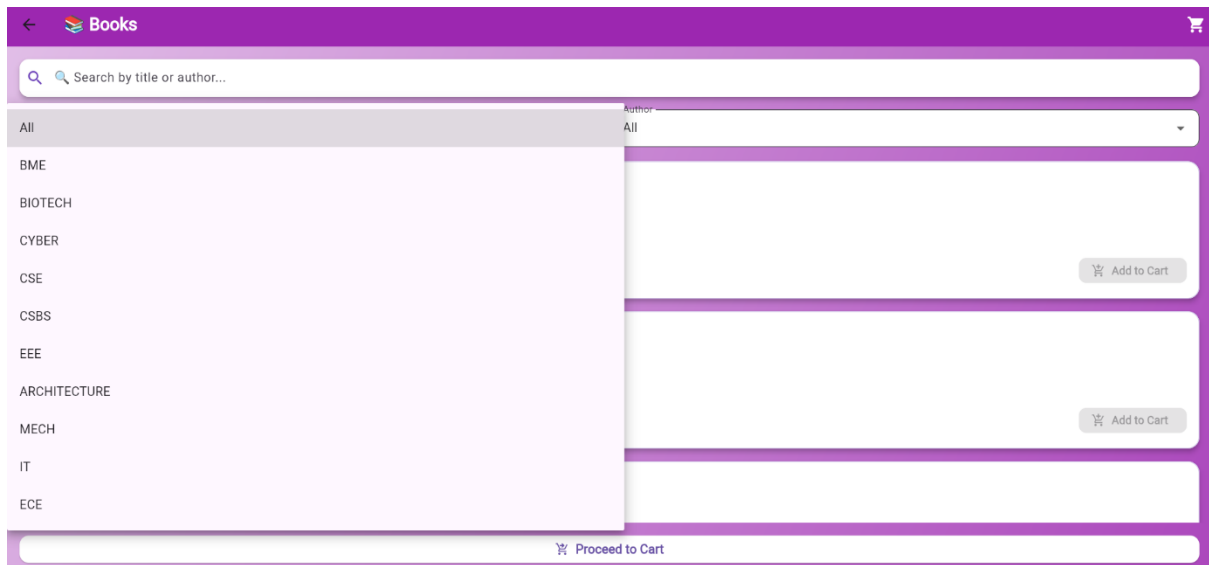


Figure 13: Departments filter

7.12 Cart page:

Figure 14 illustrates the Cart page which allows users to add books to a cart for download, reservation, or purchase.

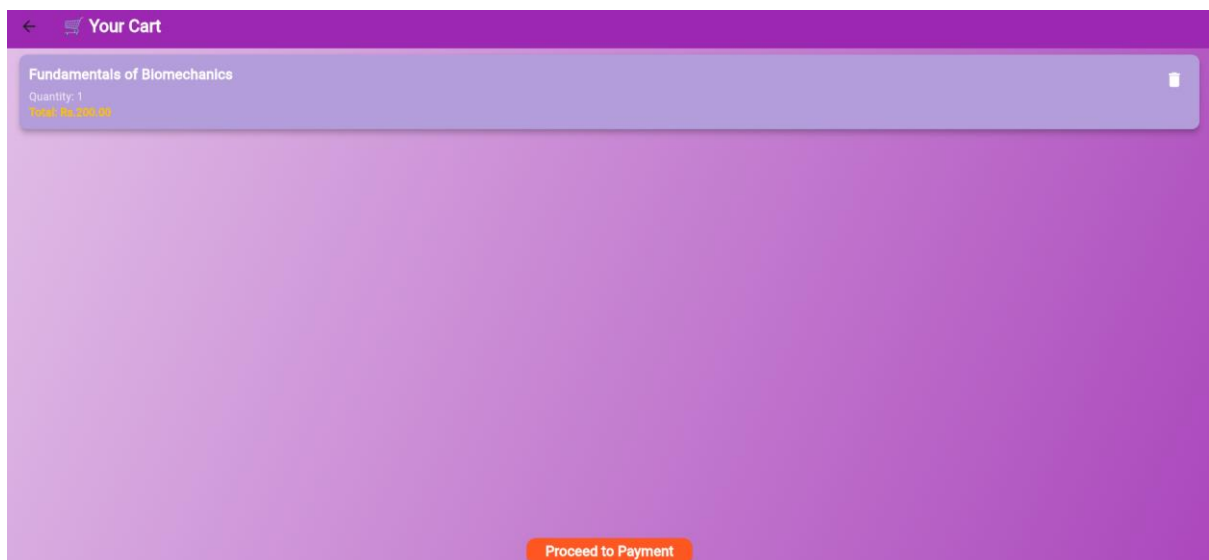


Figure 14: Cart page

7.13 Payment page:

Figure 15 illustrates the payment page, which displays the book total and user details before proceeding to payment.

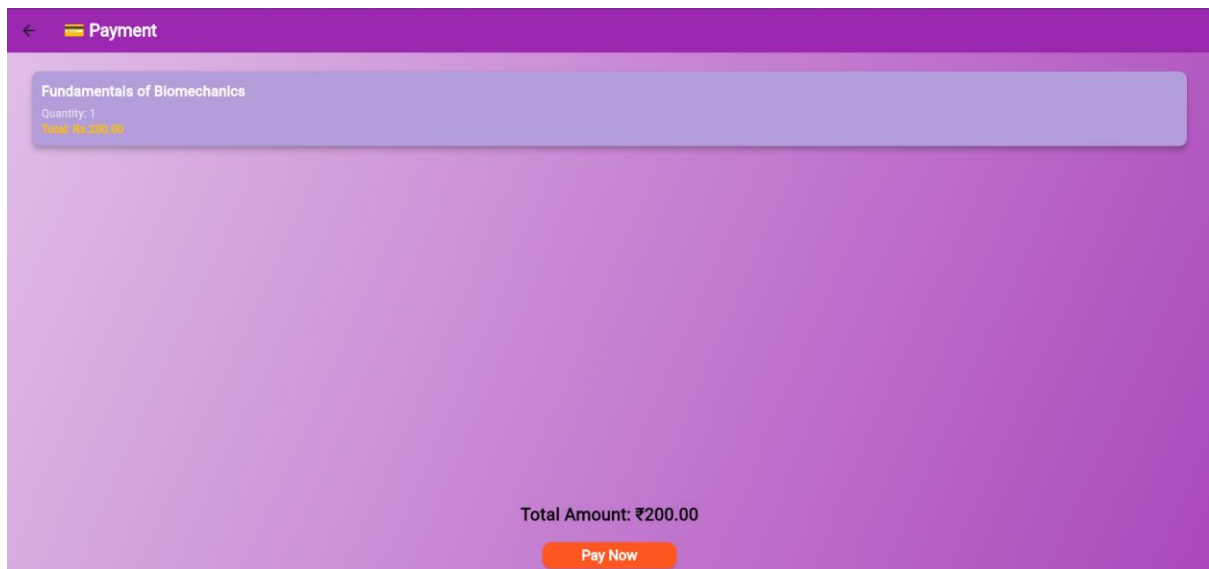


Figure 15: Payment page

7.14 Razorpay payment gateway:

Figure 16 illustrates the Razorpay payment gateway a secure payment gateway integration for books or reports.

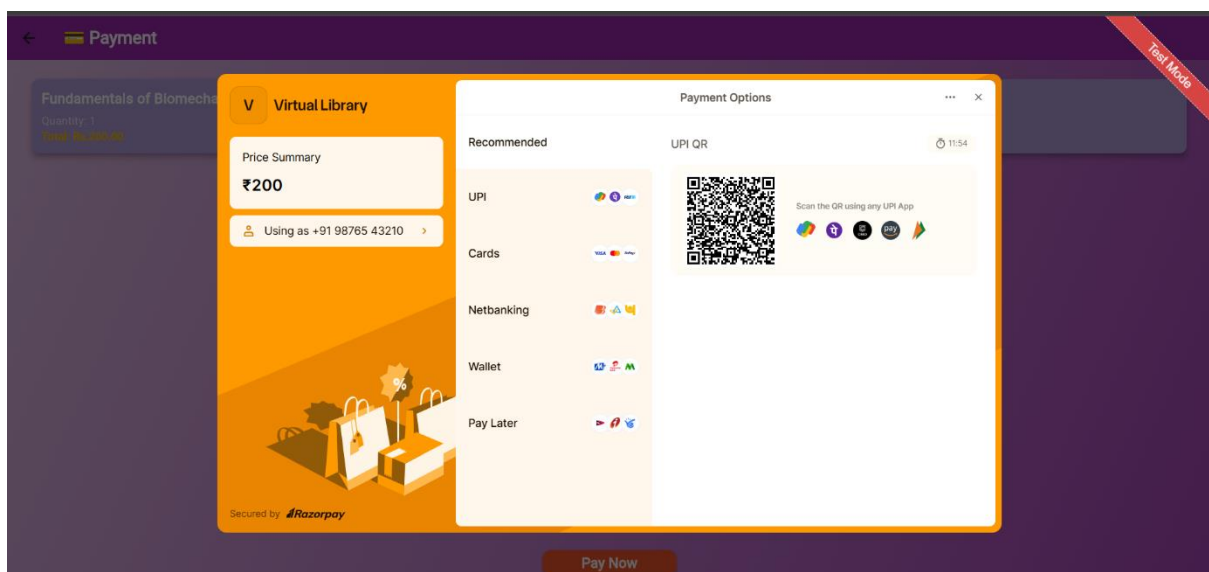


Figure 16 : Razorpay payment gateway

8. Test and Feedback

In this stage called Test stage that concludes Design Thinking process, users and stakeholders are welcomed to go through test of the prototype to offer important feedback. The goal was to watch real users work with the system and identify usability issues, which needed to be resolved using user feedback.

8.1 Testing Approach

We then conducted informal user testing sessions in:

- Fellow workers who did not take part in the UI development.
- Students from various departments
- Academic staff which can operate like instructors.
- Our project guide, our own project team, and other players of the project team
- To solicit feedback, we made each user complete the following tasks:
- Registering and logging in
- Browsing books by category
- Using their instructor profile to upload a book as course material.
- Browsing in the search bar and placing books in the cart.
- Pixicted payment process.

8.2 Feedback Collected

Table 2 displays the collected multi-source feedback which highlighted UI improvements, feature enhancements like progress indicators, dark mode, and analytics to boost usability and engagement.

| Feedback Source | Feedback Summary |
|---------------------|---|
| Team Members | Suggested adding a progress indicator during book uploads and a clearer dashboard layout. |
| Other Teams | Appreciated the clean design; recommended improving the search bar's responsiveness. |
| Students | Liked the category-based access and simple interface; some requested dark mode. |
| Faculty/Instructors | Wanted a feature to track how many students accessed their uploaded content. |

Table2: Feedback collected

9. Re-design and Implementation

This Re-design and Implementation stage was supported by the findings and feedback collected in the testing and user feedback sessions. To more positively respond to feedback from users the prototype had some changes made prior to beginning the full development process. This approach enabled us to develop a final implementation, which better captured actual user requests.

9.1 Re-design Based on Feedback

Table 3 explains the redesign that took place following the feedback from students, instructors, team members and admin testers, the first prototype was modified. Here are the key changes made

| Feedback Point | Re-design Action Taken |
|---------------------------------|--|
| UI lacked clarity in some areas | Enhanced button visibility, added tooltips, and labeled navigation clearly |
| Upload process wasn't intuitive | Added a progress bar and success alert for uploads |

Table 3: Redesign based on feedback

9.2 Final Product Implementation

After modifying the original design, the Virtual Library was developed using Flutter for the user interface and Firebase for its backend functionality. The discussed features were created to help meet the core requirements of the users established at the previous stages of the project:

Role-Based Access Control

- Students: Users can browse, search for, and get books.
- Instructors: Has the ability to upload and manage subject related resources.
- Admins: While it can create, modify, approve uploads and assign the role of users.

Categorized Resource Management

- Media is categorized into different sections such as CSE Books, EEE Books, Core Subjects and Project Reports.
- Admins can dynamically add/edit categories.

Upload & Download Functionality

- Instructors are able to upload a book (electronically), a link, or other digital materials into the relevant subject categories.
- Students have hassle-free access to and downloading of content.

10. Conclusion

With the introduction of a digital solution, the Virtual Library project has significantly improved academic institutions' capacity to control and share the materials intended for learning online. It addresses a persistent issue faced by students and educators, That there is no unified, regimented, and student-oriented online library for educational information. Libraries managed with traditional approaches can have immense quantities of information, but such systems are frequently limited by such contexts as restricted physical presence, lack of frequent updating and low capacity for diverse forms of users. This undertaking aimed at overcoming these challenges by putting in place an agile and friendly digitized infrastructure where access is guaranteed and global and uninterrupted.

According to the Design Thinking approach to the framework, the project started on the basis of delving into real user challenges. By empathetic research practices that included interviews, observation and feedback analysis, the team identified essential pain points such as facing difficulties when searching for categorized access to academic resources, poor upload workflows for educators as well as After consolidating these findings into expressed problem statements, the design objectives and the nature of the system were clearly stated.

11. Future Work

Though the present Virtual Library version functions smoothly and fulfills the specified user demands, one needs to be realized that the technology and user demands are continually changing. In order to keep up with the times and be able to fit continued growth, a string of high-end features are recommended for the evolution of the platform. To enable timely communications, a strong notification and alert system is being planned, providing the instant updates on file uploads, impending deadlines, administrative approval, grand announcements as well as specific recommendations associated with the users' choice of course and usage. Additionally, the ability to enable full dark mode and themes customization will enhance accessibility and comfort, in particular, for late-night users who can customize their visual settings in advance according to their needs. The proposed upgrades will move the Virtual Library from a stand-alone department tool to an adaptable, scalable platform capable of affecting the academic networks of several universities, online education providers, and digital education establishments.

12. Learning Outcome of Design Thinking

The adoption of Design Thinking as our guiding approach made our approach to problem-solving, team collaboration; and the creation of solutions, fundamental. The main conclusions from this project are as follows:

Empathy-Driven Design

The users became the chief consideration at every step of our design approach. By using a blend of interviews, surveys and user role evaluation, we brought to light user pain points that may possibly have been kept under wraps if technology was our only focus. By this process, we gained greater awareness of design's role in usability.

Structured Ideation and Creativity

Design Thinking added value to the ideation phase, helping to provoke divergent thinking to come up with many possibilities. After free discussion of ideas, we discussed concepts jointly and evidenced the most efficient and user-based option. Through the use of tools such as mind mapping and value proposition canvases, we managed to bring things on course and make informed decisions about the needs of the users.

Rapid Prototyping and Iteration

We began the process of creating prototypes early on and improved them iteratively, rather than toiling to create a perfect product. This adaptive approach enabled us to advance faster and improve what we offer more effectively based on on-the-spot feedback.

Real-World User Feedback

Colleague-citizen testing of our prototype showed us that our assumptions often diverged from our observations. We grew the user flows and improved the overall user experience by migrating directly to input from users, consciously re-engineering the outcome.

Team Collaboration and Communication

The project demanded a continuous collaboration between UI/UX designers, backend developers and key stakeholders in order to move the project forward. Throughout the project, the team collected valuable knowledge about coordinating complex teams, sharing roles effectively, and presenting ideas about design clearly. Collaborating, the team was able to productively optimize development processes and improve the understanding of user-centered design and agile methodologies.

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