

Introduction

This document outlines the planning and design phase for a peer-to-peer (P2P) Bitcoin lending platform. The platform operates under a 100% collateralized loan model, ensuring security without relying on traditional financial intermediaries. This documentation covers software architecture, development methodologies, client-server architecture, ethical considerations, and user stories.

1. Planned Software Architecture

Programming Paradigm

Our project follows an **object-oriented programming (OOP)** paradigm. OOP is a paradigm that organises code into 'objects', bundles of data (properties) and functions (methods) that operate on that data. It helps model real-world entities and makes programs more scalable, reusable, and maintainable. OOP uses principles like encapsulation (hiding internal data), inheritance (sharing functionality between objects), polymorphism (handling different types through a unified interface), and abstraction (simplifying complex realities).

- **Language:** JavaScript (Node.js, Express backend, and React frontend)
- **Objects:**
 - User
 - username, walletId, email, password, createdAt, isActive, isAdmin
 - LoanRequest
 - borrowerId, requestAmount, interestTermId, cryptocurrencyId, requestDate, expiryDate
 - Deal
 - lenderId, loanDetailsId (reference to LoanRequest), dealDate, isComplete
 - Collateral
 - dealId, amount
 - Transaction
 - fromUserId, toUserId, dealId, amount, isLoanRepayment, expectedDate, paymentStatus
 - InterestTerm
 - loanLength, interestRate
 - Cryptocurrency
 - symbol, name

Each object will have distinct properties and methods, reflecting real-world entities and actions.

Below is a diagram outlining how OOP is structured, using classes, instances of that class (objects), properties, and methods.

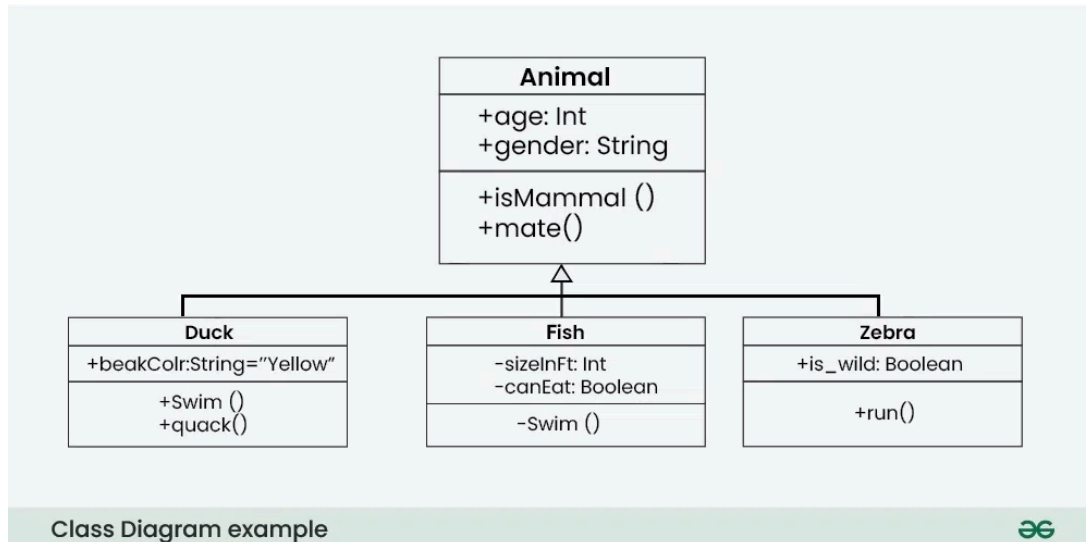


Figure 1: UML Class Diagram example (GeeksforGeeks, n.d.)

Figure 2 below demonstrates how a Student class consisting of a `firstName`, `lastName`, and `age` is created. Three instances of this class are created, each being a different student with different attributes.

```
class Student{
  constructor(firstName, lastName, age){
    this.firstName = firstName;
    this.lastName = lastName;
    this.age = age;
    console.log("New Student Created")
  }
}

const Avery = new Student("Avery", "Ackles", 12);
const Benny = new Student("Benny", "Barnes", 13);
const Carrie = new Student("Carrie", "Peggy", 13);
```

Figure 2: JavaScript Classes for OOP example (Dondi, 2021)

Figure 3 is an example of OOP in JavaScript, where inheritance is used. A 'person' class is created, and another class or object inherits its properties. A 'students' object inherits the 'name' property from 'person' and adds a new property, 'id'.

```
class person {
  constructor(name){
    this.name = name;
  }
  //method to return the string
  toString(){
    return `Name: ${this.name}`
  }
}

class students extends person{
  constructor(name,id){
    //super keyword to for calling above class constructor
    super(name);
    this.id = id;
  }
  toString(){
    return `${super.toString()}, Student ID: ${this.id}`;
  }
}

let student1 = new students("Hridoy",25)
console.log(student1.toString())  Name: Hridoy, Student ID: 25
```

Figure 3: Object-Oriented Programming in JavaScript (Francis, 2020)

App Architecture

The project adopts a **Model-View-Controller (MVC)** architecture, a design pattern used in web development to separate concerns:

- **Model:** Manages the data and business logic (e.g, database, data structures). We will be using Mongoose.
- **View:** Handles the user interface and presentation (what the user sees). We will be using React.js for our view.
- **Controller:** Acts as an intermediary between the model and the view, processing user input and updating the model or view as needed. Express.js routes manage API requests and link models to the frontend.

This separation makes the code more organised, maintainable, and scalable.

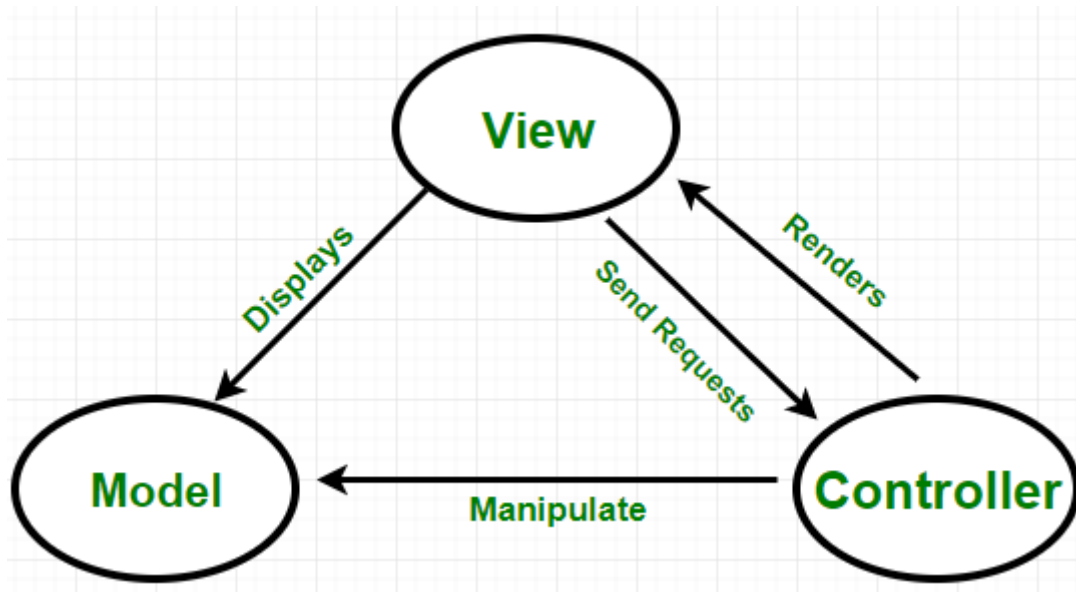


Figure 4. Model-View-Controller Diagram (GeeksforGeeks, n.d)

Additionally, MVC enhances testing and debugging by allowing each component to be developed and tested in isolation, particularly the controller. This modular structure not only supports easier maintenance but also promotes scalability and flexibility. Since components can be reused across different applications, developers can save time and effort when working on projects with similar requirements. Overall, MVC encourages a more structured, manageable, and efficient approach to application development.

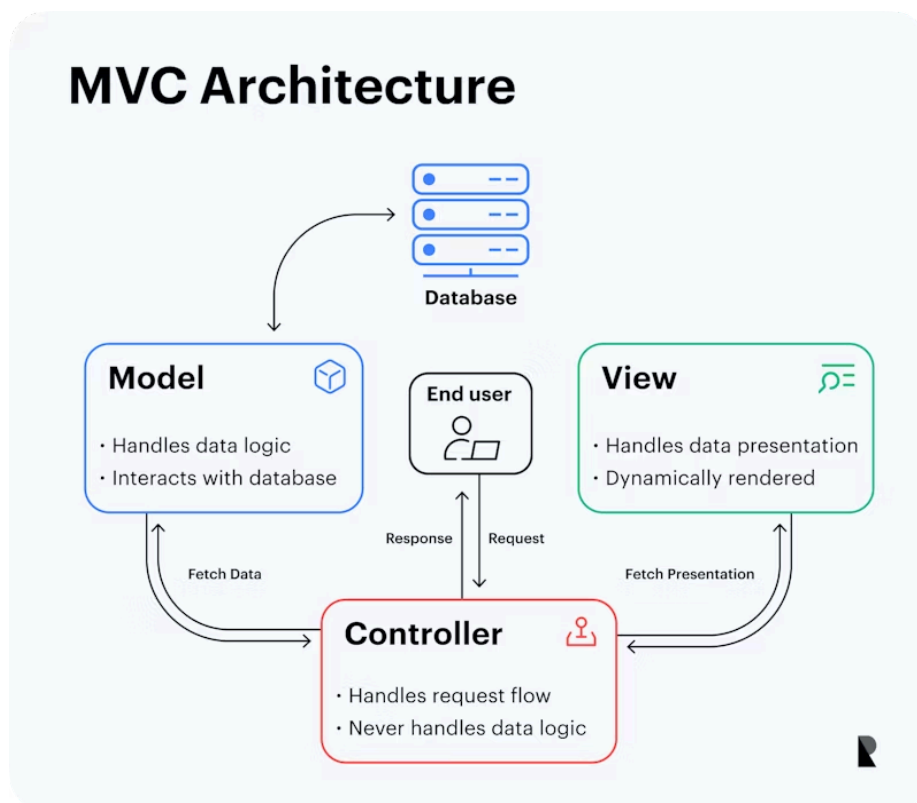


Figure 5. MVC Architecture (Ramotion, 2023)

Figure 6 is a minimal but solid illustration of the MVC pattern in action:

- **Model** stores and manages data.
- **View** handles displaying the data.
- **Controller** links the user action (adding items) to updating the **model** and **view**.



```
1 // Model
2 const Model = {
3   data: [],
4   add(item) {
5     this.data.push(item);
6   }
7 };
8
9 // View
10 const View = {
11   render(data) {
12     console.clear();
13     data.forEach((item, i) => console.log(`${i + 1}. ${item}`));
14   }
15 };
16
17 // Controller
18 const Controller = {
19   addItem(item) {
20     Model.add(item);
21     View.render(Model.data);
22   }
23 };
24
25 // Usage
26 Controller.addItem("Learn MVC");
27 Controller.addItem("Build a project");
28
```

Figure 6. MVC Code Snippet (Williams, 2025)

2. Software Development Methodologies

Project Management Methodology

We will adopt a **hybrid Waterfall-Agile methodology**:

- **Initial phases:** Planning and documentation follow **Waterfall**.
- **Development phases:** Coding adopts an **Agile** approach for iterative development and integration.

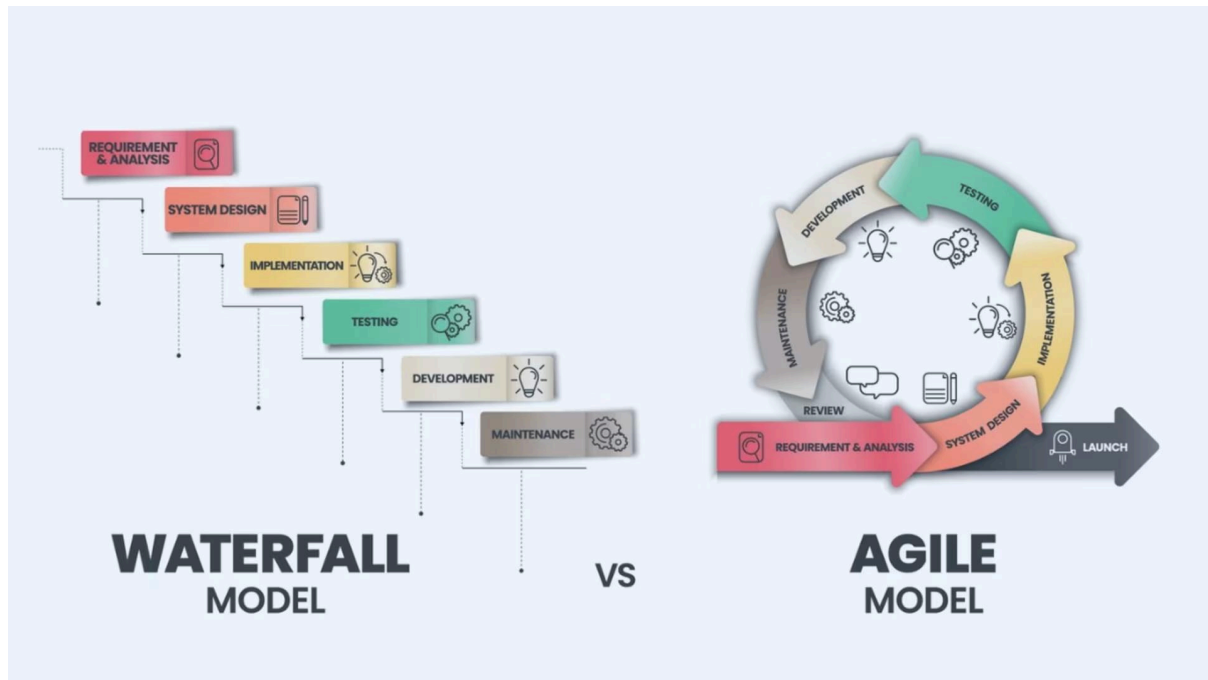


Figure 7: A side-by-side comparison of Waterfall vs Agile (BairesDev Editorial Team, n.d.)

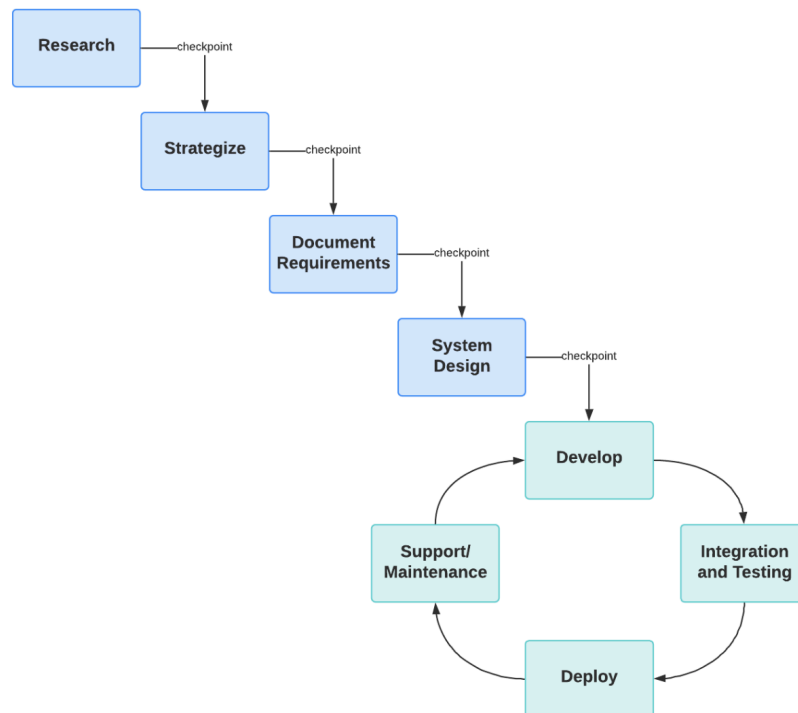


Figure 8: A hybrid Waterfall-Agile approach (Lucidchart, n.d.)

We have chosen a **hybrid methodology** (visualised in Figure 8) to match the natural progression of the project. For the planning and documentation phase, a **Waterfall approach** is ideal, as tasks are largely sequential: we must finalise architecture decisions,

user stories, and data models before meaningful development can begin. Each component builds upon the last, making linear execution efficient. However, once we reach the development phase, we will benefit from **Agile practices**, allowing us to work in parallel. With two developers, we can independently build and iterate on different functionalities, using short feedback loops to stay aligned and resolve blockers quickly.

Task Management Methodology

A dual approach will be used:

- **Kanban Board:** For task visualisation and progress tracking.
- **Scrum elements:** Short stand-ups during coding phases to address blockers and maintain alignment.

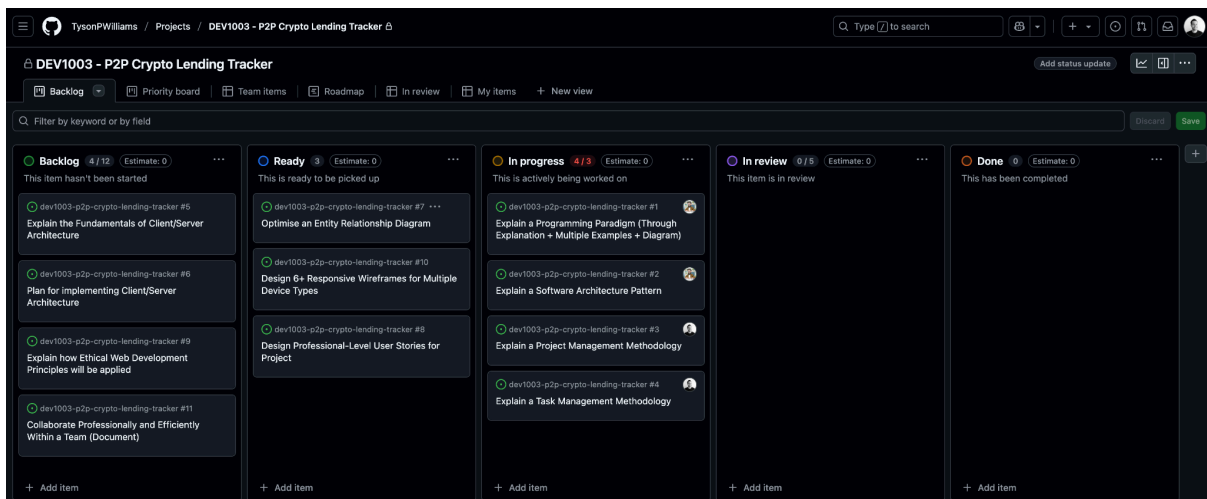


Figure 9: A screenshot from this assignment's [GitHub project](#) kanban board (Authors, 2025)

To manage tasks effectively throughout the project, we are adopting a two-pronged approach that combines **Kanban** and **Scrum** methodologies. The Kanban board, hosted via GitHub Projects (see Figure 9), provides a visual overview of task progress using clearly defined columns: *Backlog*, *In Progress*, *Review*, and *Complete*. This structure helps us prioritise tasks, track ownership, and maintain momentum.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Sprint 1							
Sprint 2							
Stand-ups							

Figure 10: An example of a week in the development cycle (Authors, 2025)

Alongside Kanban, we will integrate **Scrum elements** during the development phases. Specifically, we plan to run **bi-weekly sprints**, with short daily **stand-up meetings** between team members to discuss progress, surface blockers, and reassign tasks if needed (see

Figure 10). This combination ensures we stay responsive to project needs while maintaining clarity and accountability across the workload.

The flexibility of Scrum supports our Agile development cycles, while the structure of Kanban keeps our planning grounded and transparent.

3. Client-Server Architecture

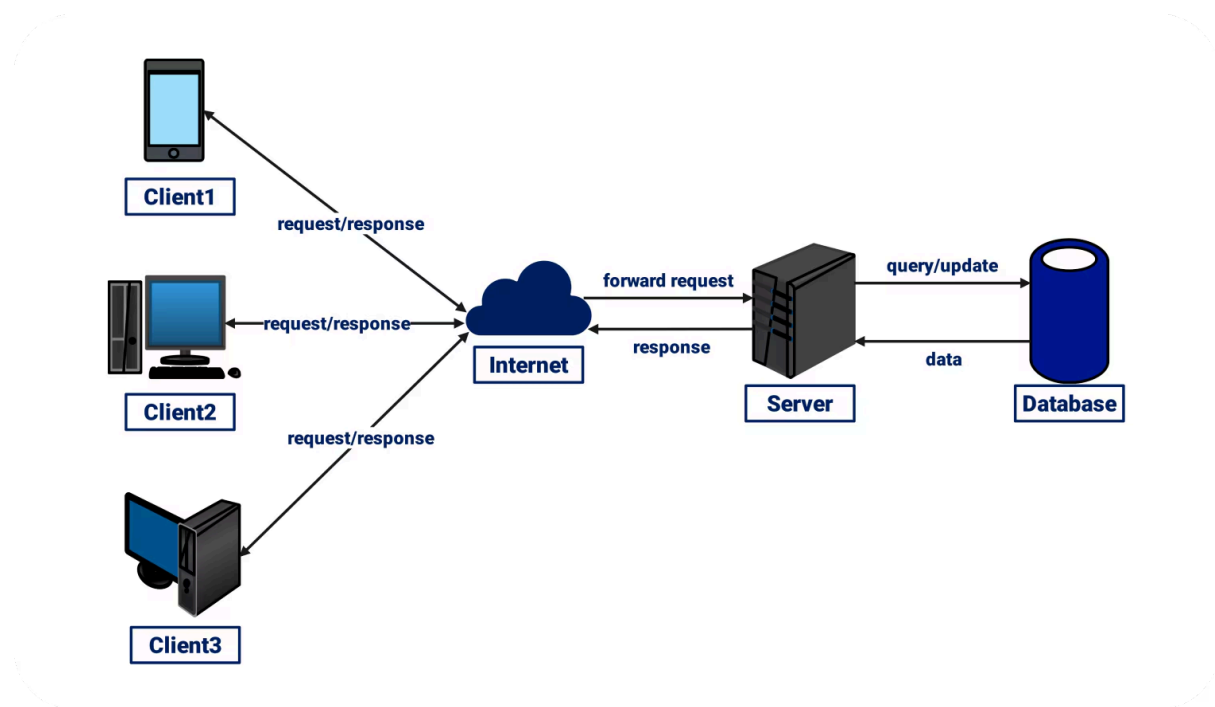


Figure 10. Network Diagram for Client-Server (EdrawMax, n.d)

Fundamentals of Client-Server Architecture

Client/Server Communication: In web applications, the client (e.g., a web browser) sends requests to the server using protocols like HTTP or HTTPS. The server processes these requests and returns responses, facilitating data exchange and functionality. (IOSR Journal of Computer Engineering, 2022)

Data Distribution: Data distribution involves the allocation of data across different servers or locations to enhance performance, scalability, and reliability. Strategies include centralized, decentralized, and distributed systems, each with its trade-offs. (Ceglar, Rak and Jezic, 2007)

Feature Distribution: Feature distribution pertains to assigning application functionalities between the client and server. Client-side features (e.g., input validation) enhance

responsiveness, while server-side features (e.g., database operations) ensure data integrity and security. (Farrell, 2020)

Authorization: Authorization determines user permissions for accessing resources. Implementations often use Role-Based Access Control (RBAC) and tokens like JSON Web Tokens (JWT) to manage and verify permissions securely. (Pardede, Nayak and Sain, 2022)

Validation: Validation ensures that input data meets predefined formats and constraints, preventing errors and security vulnerabilities. It is performed both on the client side for immediate feedback and on the server side for security enforcement. (Sule, Haruna and Dogo, 2014)

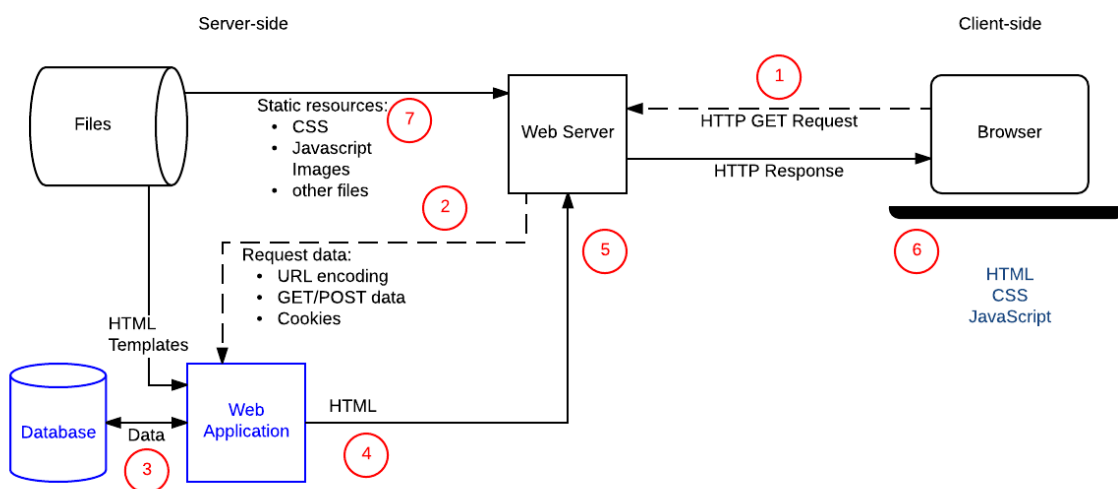


Figure 11. Client-server overview (MDN Web Docs, n.d.)

The diagram above illustrates the dynamic HTTP request-response cycle, showing how a client sends a request to the server, which processes it and returns a response, forming the core of client-server communication

Plan for Implementing Client/Server Architecture in Our Project

Tech Stack: JavaScript, Node.js, Express, MongoDB, Mongoose, React.js, HTTP

1. Client/Server Communication

Client-side (React) communicates with the server (Express) via RESTful HTTP requests using axios or fetch. JSON is used for all data exchange. CORS and HTTPS are configured for secure and cross-origin communication. WebSocket/Socke.IO may be introduced for real-time transaction updates.

2. Data Distribution

MongoDB stores wallets, transaction logs, and user data. Mongoose manages schemas and relationships. Data is structured for performance using indexing. Future scalability may include replication and sharding.

3. Data Security

All traffic uses HTTPS. Passwords are hashed (bcrypt). JWT is used for secure, stateless user authentication. API endpoints are protected with rate limiting, input validation, and security middleware (e.g., Helmet, CORS policies).

4. Feature Distribution

- **Client:** UI rendering, API consumption, local validation, token storage.
- **Server:** Business logic, DB operations, authentication, input validation. Environment variables control config for production and development environments.

5. Authorisation

JWT handles token-based user sessions. Protected routes verify tokens via middleware. Role-based access control restricts sensitive operations. Tokens are stored in HTTP-only cookies or memory.

6. Validation

- **Client:** Uses React validation tools or custom functions.
- **Server:** Validates via Mongoose schemas and custom middleware. Invalid requests return structured errors; logs are maintained for monitoring.

4. Entity Relationship Diagram (ERD)

Key Entities:

- Users
- LoanRequests
- InterestTerms
- Cryptocurrencies
- Deals
- Collateral
- Transactions

The database schema for our P2P Bitcoin lending platform has been normalised to **Third Normal Form (3NF)**. Each table includes a single-column primary key, and all non-key attributes fully depend on that key, satisfying **1NF** and **2NF**. No transitive dependencies exist between non-key attributes, meeting the requirements of **3NF**. Foreign keys are used appropriately to model relationships between entities, ensuring data integrity and minimising redundancy.

For example, LoanRequests references Users, Cryptocurrencies, and InterestTerms, while Deals links to both borrowers and lenders via their respective user_id. The Collateral, Transaction, and Repayment data have been separated into dedicated tables, which further supports modularity and maintainability of the system's data model.

Please refer to **Appendix A - Entity Relationship Diagram** for the full diagram.

5. User Stories

Persona 1: The Borrower – “Alex”

- **Need:** Access fast, trustless loans without involving traditional financial institutions.
- **User Story:** *As a borrower, I want to securely request a Bitcoin loan using my wallet, so that I can access funds without relying on banks or credit checks.*
- **Want/Feature:**
 - Wallet-based authentication (e.g., MetaMask)
 - Smart contract-backed loan request and repayment process
- **Justification:** Enables financial inclusivity and autonomy through decentralised borrowing, reducing dependency on banks.

Persona 2: The Lender – “Jordan”

- **Need:** Grow their Bitcoin holdings by passively earning interest through lending.
- **User Story:** *As a lender, I want to view and select loan requests to fund based on risk and return, so I can earn yield from my Bitcoin.*
- **Want/Feature:**
 - Dashboard to view loan offers with borrower credit scores or risk indicators
 - Auto-lend feature for small, diversified loans
- **Justification:** Empowers lenders to use idle assets for passive income, incentivising liquidity on the platform.

Persona 3: The Admin – “Riley”

- **Need:** Maintain platform integrity and prevent abuse or fraud.
- **User Story:** *As an admin, I want to oversee transactions and user behavior via an admin panel, so that I can ensure platform stability and compliance.*
- **Want/Feature:**

- Admin dashboard for transaction logs and user reports
- Ability to suspend accounts or flag suspicious activity
- **Justification:** Critical for trust, compliance, and maintaining a secure ecosystem for users.

Consolidated Wants/Functionalities Summary

1. **Wallet-Based Authentication** – For secure, decentralised access.
 2. **Loan Request/Review System** – Supports both borrower and lender experiences.
 3. **Smart Contract Automation** – Ensures trustless, enforceable loan agreements.
 4. **Admin Monitoring Tools** – Maintain security, trust, and compliance.
-

6. Ethical Web Development Principles

Our project will adhere to the following principles from ethicalweb.org (Scott, 2016):

- **Accessibility:** Usable by people with disabilities.
- **Privacy:** Minimal data collection, wallet-based login.
- **Security:** Secure encryption for transactions.
- **Transparency:** Clear terms and user rights.

Our project is guided by ethical web development principles prioritising accessibility, privacy, security, and transparency. To ensure inclusivity, we will follow the *Web Content Accessibility Guidelines (WCAG) 2.1* by using semantic HTML and accessibility-focused tools such as eslint-plugin-jsx-a11y. This supports screen readers and keyboard navigation for users with disabilities.

While we intend to implement a wallet-based login system in the future, aligned with decentralised finance (DeFi) values and user privacy, for this assignment's minimum viable product (MVP), user accounts will require personal information such as email and passwords. Passwords will be securely hashed using bcrypt before storage.

Security is a key focus, with all client-server communication protected by HTTPS. We will also follow best practices from the *Open Worldwide Application Security Project (OWASP, 2025)*, mitigating risks such as cross-site scripting (XSS) and cross-site request forgery (CSRF). Tools like Helmet.js will secure HTTP headers, and Zxcvbn.js may be integrated to support password strength validation in future iterations.

Finally, transparency will be maintained by clearly communicating all loan terms, platform features, and user rights within the application's interface, ensuring users understand how their data and interactions are handled.

7. Wireframes

Wireframes illustrate the layout and page relationships for the following views:

- Landing page
- Log in/sign up page
- User dashboard
- Admin dashboard
- Browse loans
- Request a loan
- Loan terms
- Transactions

Each is presented in three formats:

- Desktop
- Tablet
- Mobile

Please refer to Appendix B - Wireframes for diagrams.

References

BairesDev Editorial Team (n.d.) *Agile vs. Waterfall: Choosing the Right Project Management Style for Your Team*. Available at: <https://www.bairesdev.com/blog/agile-vs-waterfall/>

(Accessed: 1 May 2025).

Ceglar, A., Rak, M. and Jezic, G. (2007) 'Effective data distribution and reallocation strategies for fast query processing', in Matoušek, R. (ed.) *Proceedings of the 16th International Conference on Information Systems Development*. Berlin: Springer. Available at: https://link.springer.com/chapter/10.1007/978-3-540-78849-2_55 (Accessed: 4 May 2025).

(Accessed: 4 May 2025).

Dondi, J. (2021) *How to use JavaScript Classes for Object-Oriented Programming*. Available at:

<https://javascript.plainenglish.io/how-to-use-javascript-classes-for-object-oriented-programming-8f300d5f71a5> (Accessed: 2 May 2025).

EdrawMax (n.d.) *Network Diagram for Client-Server*. Available at:

<https://edrawmax.wondershare.com/templates/network-diagram-for-client-server.html>

(Accessed: 2 May 2025).

Farrell, B. (2020) 'Web application architecture', in *Practical Node.js: Building Real-World Scalable Web Apps*. 2nd edn. Apress. Available at:

https://link.springer.com/chapter/10.1007/978-1-4842-8142-0_2 (Accessed: 4 May 2025).

Francis, A. (2020) *Intro to Object-Oriented Programming in JavaScript*. Medium. Available at:

<https://medium.com/swlh/intro-to-object-oriented-programming-in-javascript-fe90c70ab316>

(Accessed: 29 April 2025).

GeeksforGeeks (n.d.) *Model-View-Controller (MVC) Architecture for Node Applications*.

Available at:

<https://www.geeksforgeeks.org/model-view-controllermvc-architecture-for-node-applications/>

(Accessed: 2 May 2025).

GeeksforGeeks (n.d.) *Unified Modeling Language (UML) Class Diagrams*. Available at:

<https://www.geeksforgeeks.org/unified-modeling-language-uml-class-diagrams/> (Accessed:

29 April 2025).

IOSR Journal of Computer Engineering (2022) *A Study on the Client Server Architecture and Its Usability*. Available at:

<https://www.iosrjournals.org/iosr-jce/papers/Vol24-issue4/Ser-1/G2404017376.pdf>

(Accessed: 4 May 2025).

Lucidchart (n.d.) *Agile-Waterfall Hybrid: Is It Right for Your Team?* Available at:

<https://www.lucidchart.com/blog/is-agile-waterfall-hybrid-right-for-your-team> (Accessed: 1

May 2025).

MDN Web Docs (n.d.) *Client-server overview*. Available at: https://developer.mozilla.org/en-US/docs/Learn_web_development/Extensions/Server-side/First_steps/Client-Server_overview (Accessed: 4 May 2025).

OWASP Foundation (2025) *OWASP: Open Worldwide Application Security Project*. Available at: <https://owasp.org/> (Accessed: 7 May 2025).

Pardede, E., Nayak, R. and Sain, S.L. (2022) 'Enhancing JWT authentication and authorization in web applications', *Computers*, 12(4), p.78. Available at: <https://www.mdpi.com/2073-431X/12/4/78> (Accessed: 4 May 2025).

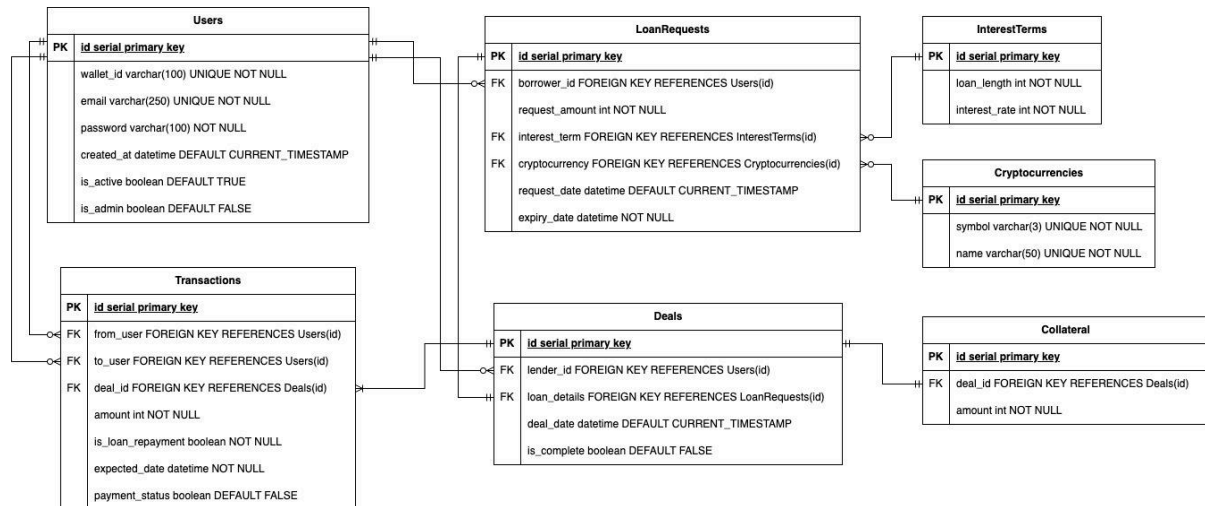
Ramotion (2023) *MVC Architecture: Simplifying Web Application Development*. Available at: <https://www.ramotion.com/blog/mvc-architecture-in-web-application/> (Accessed: 2 May 2025).

Scott, A. (2016) *Ethical Web Development*. Available at: <https://www.ethicalweb.org/> (Accessed: 1 May 2025).

Sule, A.S., Haruna, A. and Dogo, E.M. (2014) 'Input validation vulnerabilities in web applications', *Journal of Software Engineering*, 8(2), pp.116–126. Available at: <https://scialert.net/fulltext/?doi=jse.2014.116.126> (Accessed: 4 May 2025).

World Wide Web Consortium (W3C) (2018) *Web Content Accessibility Guidelines (WCAG) 2.1*. W3C Recommendation, 5 June. Available at: <https://www.w3.org/TR/WCAG21/> (Accessed: 1 May 2025).

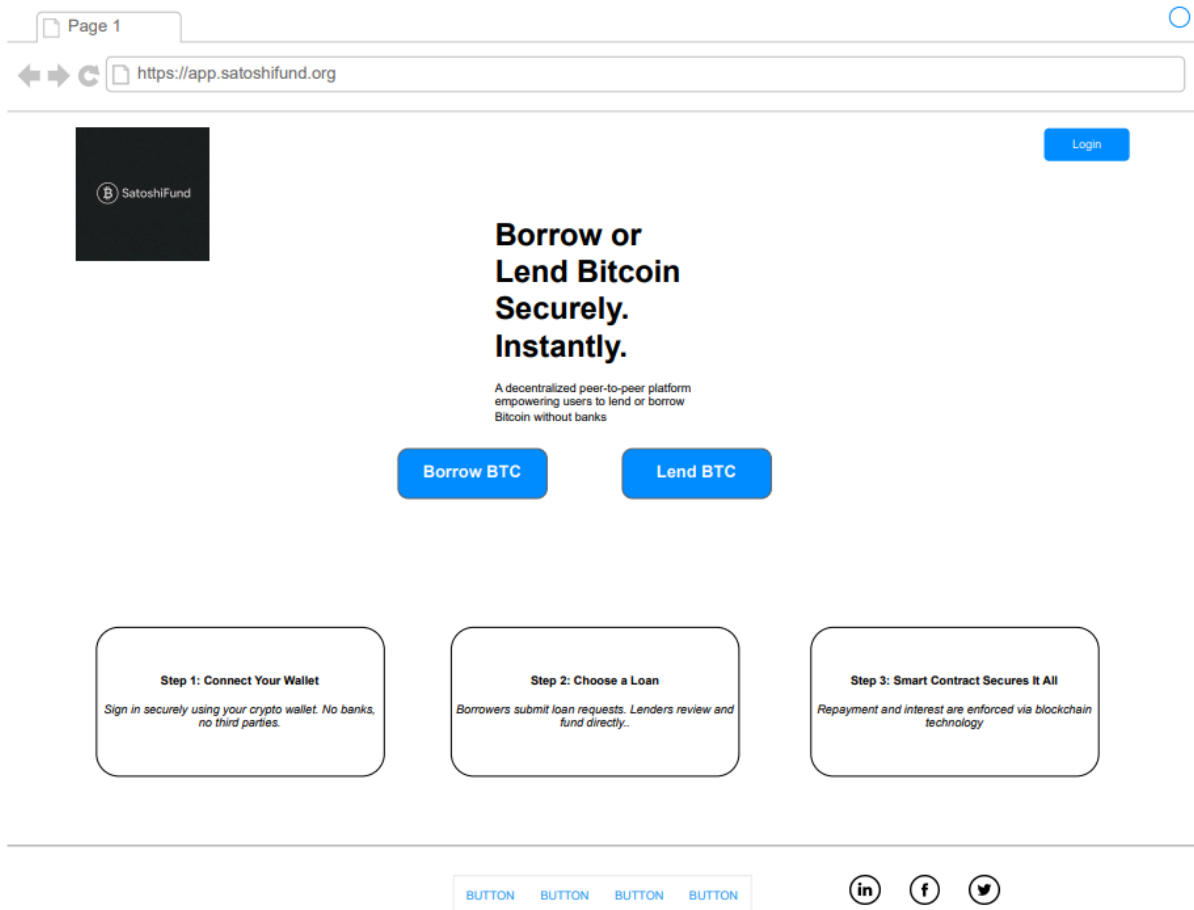
Appendix A - Entity Relationship Diagram (ERD)



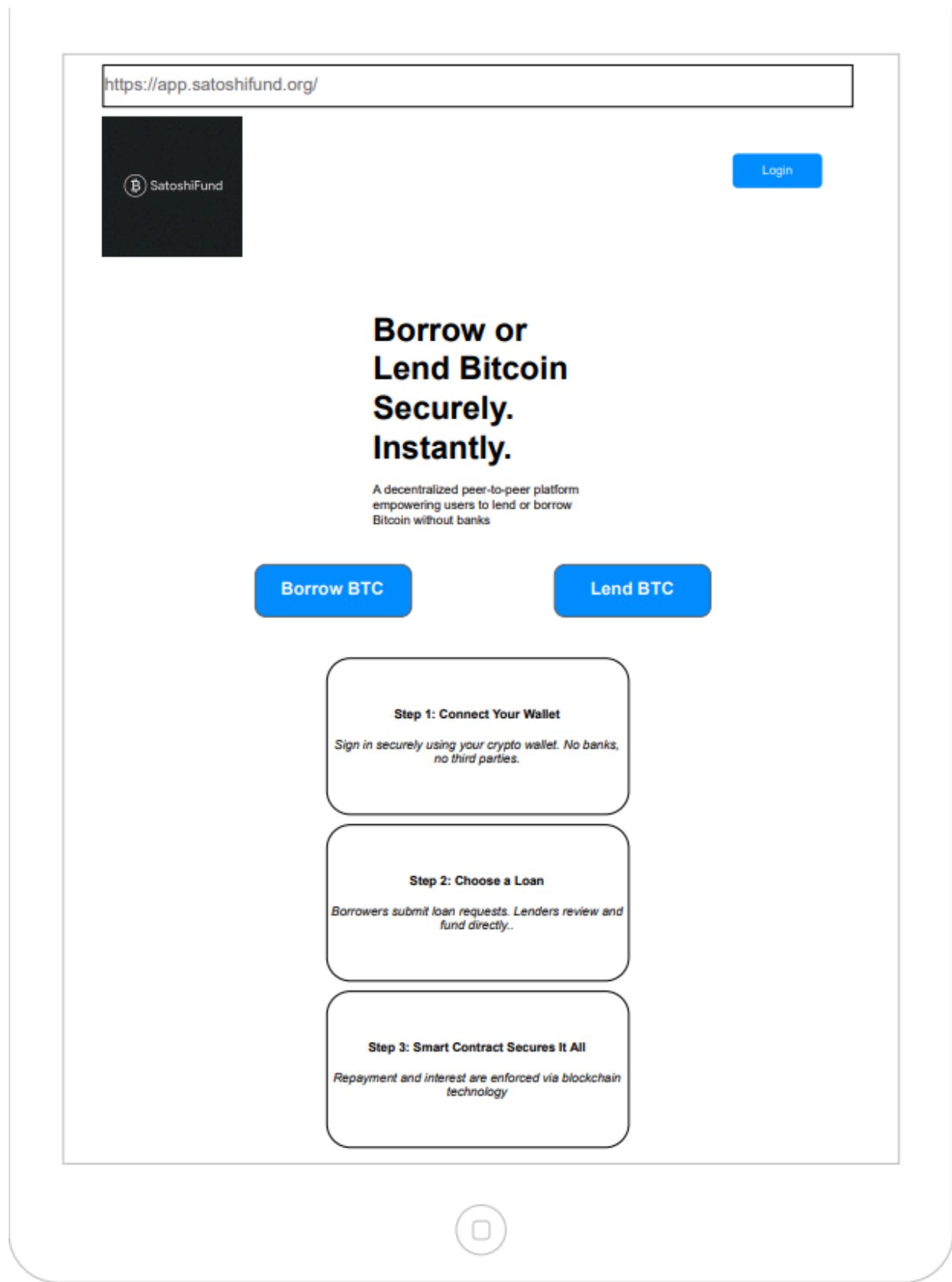
Appendix B - Wireframes

Landing Page

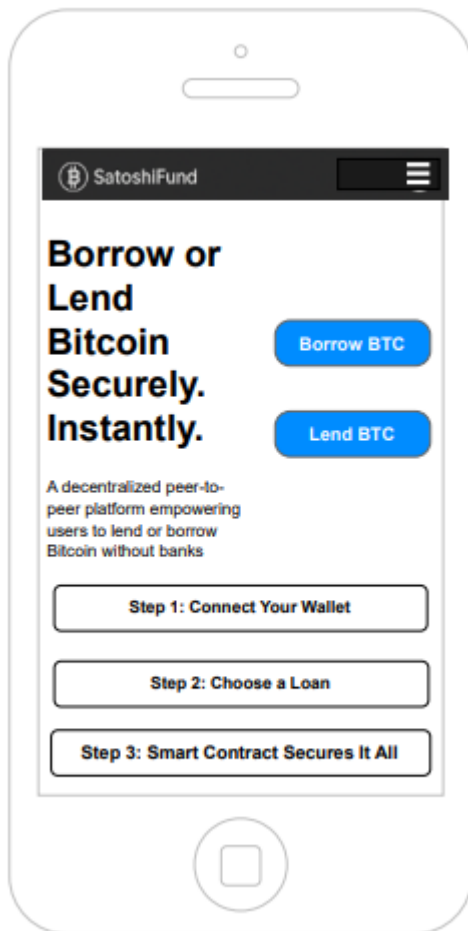
Desktop



Tablet

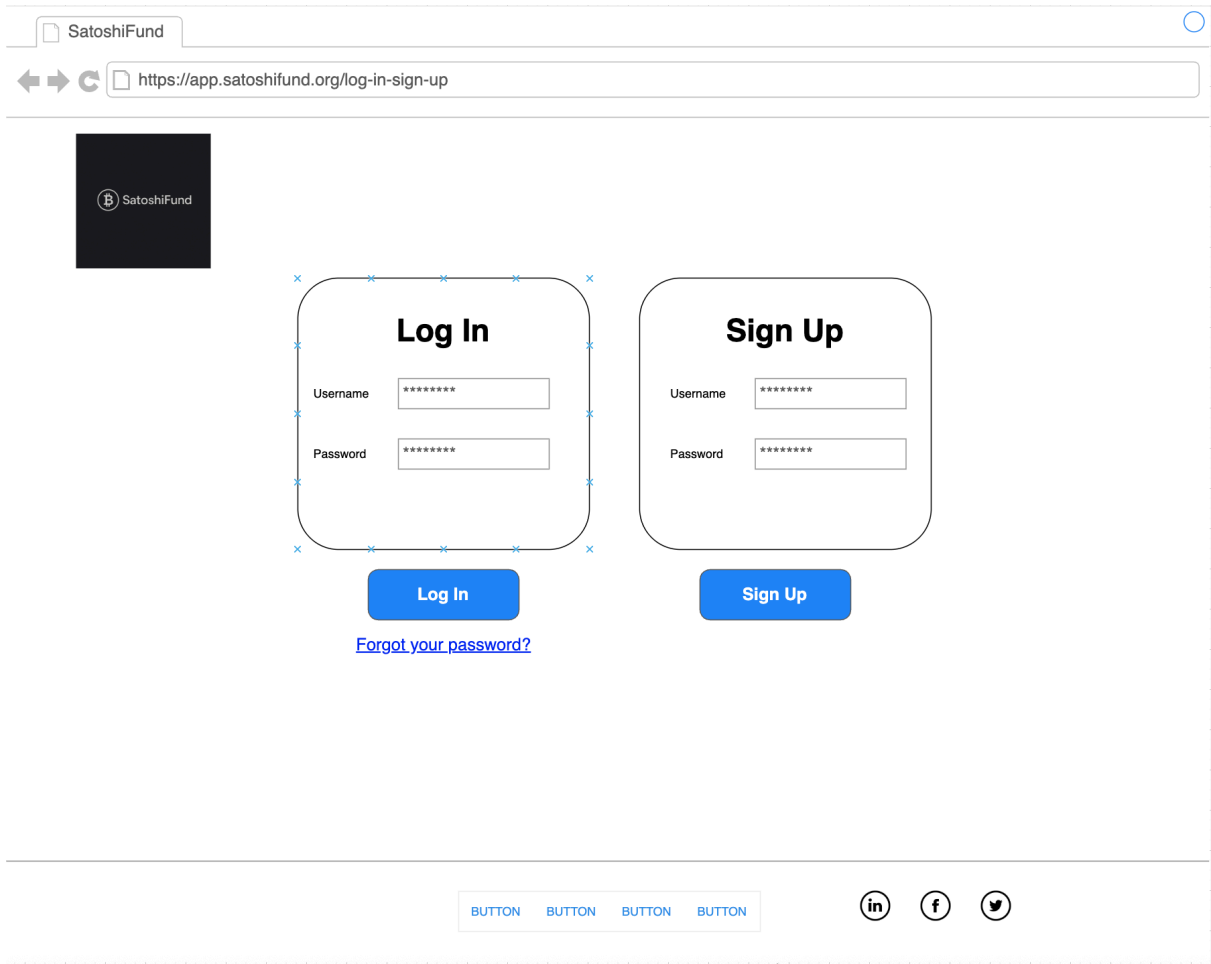


Mobile

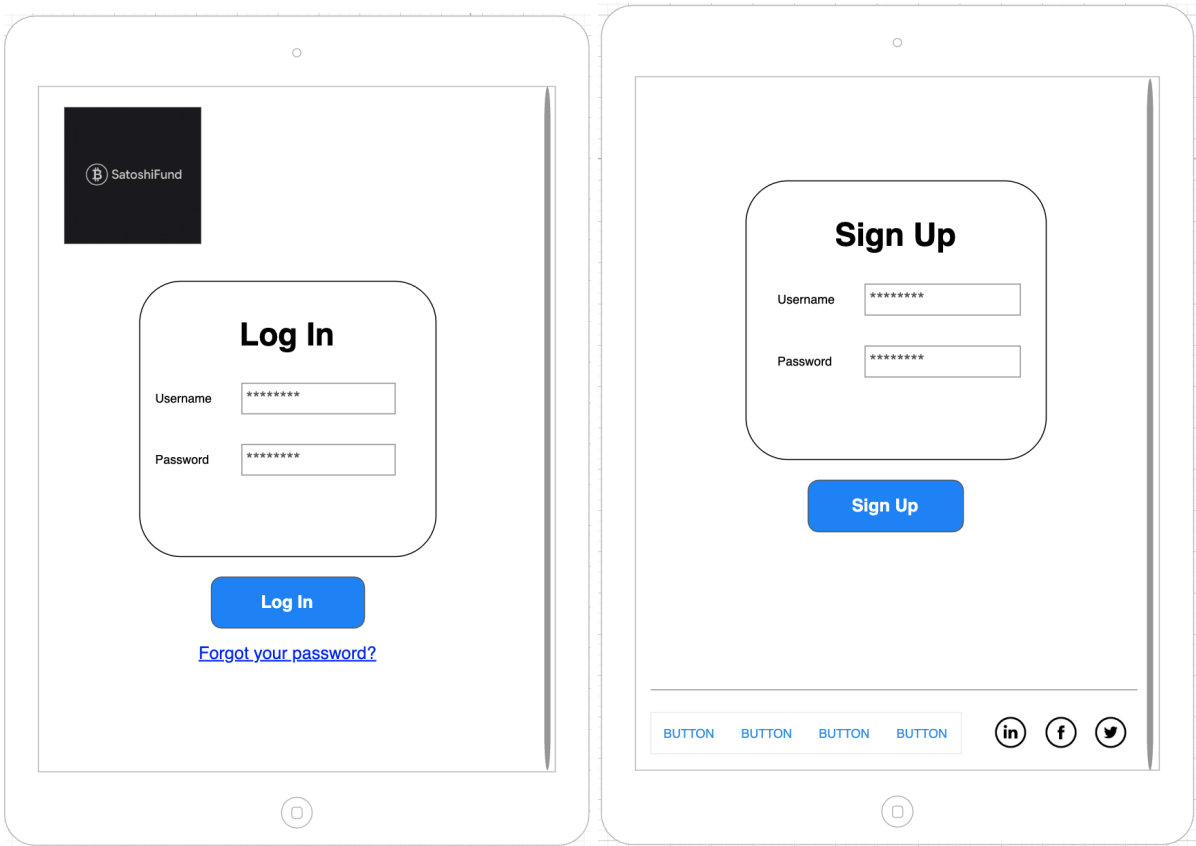


Login/Register

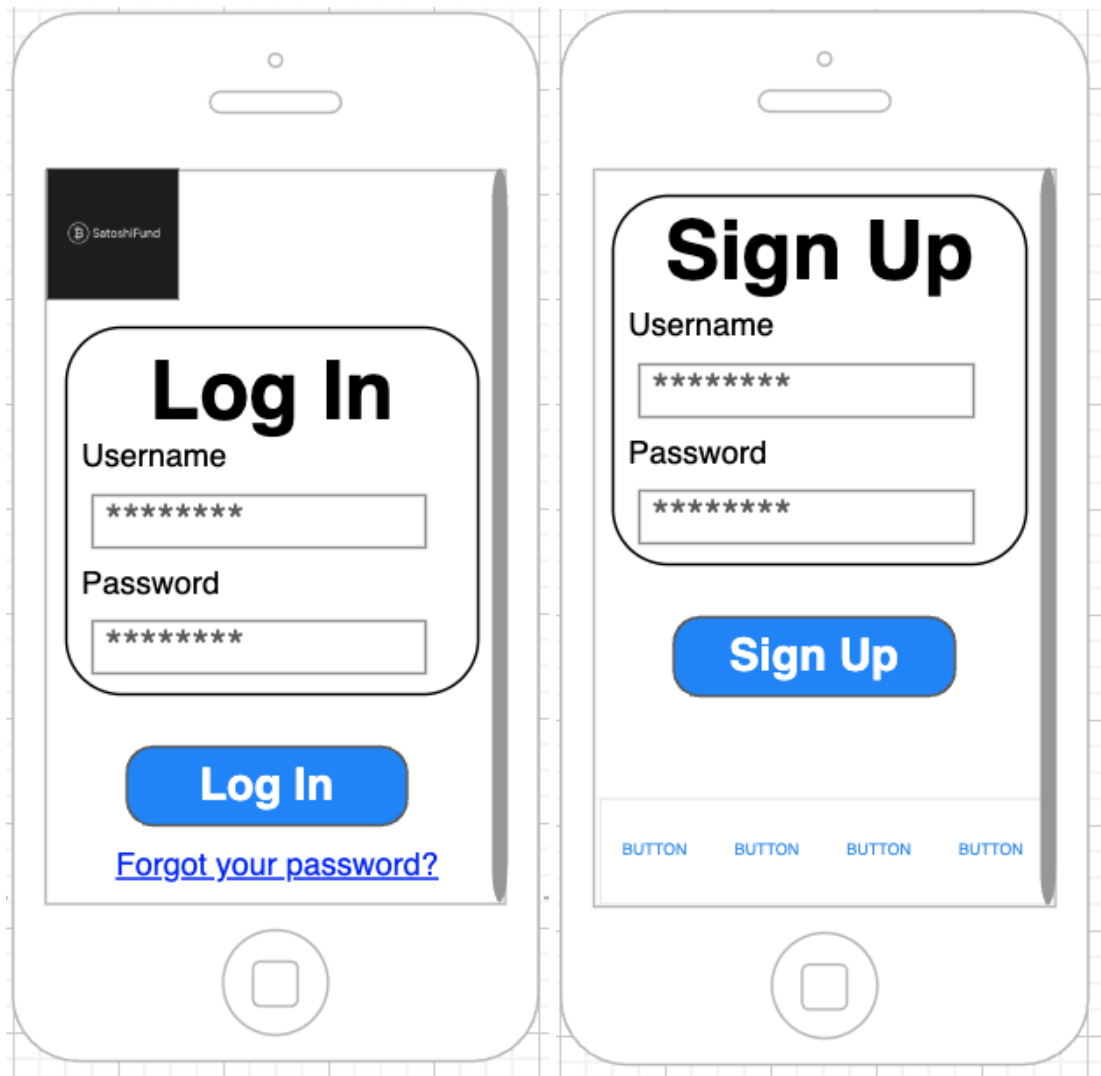
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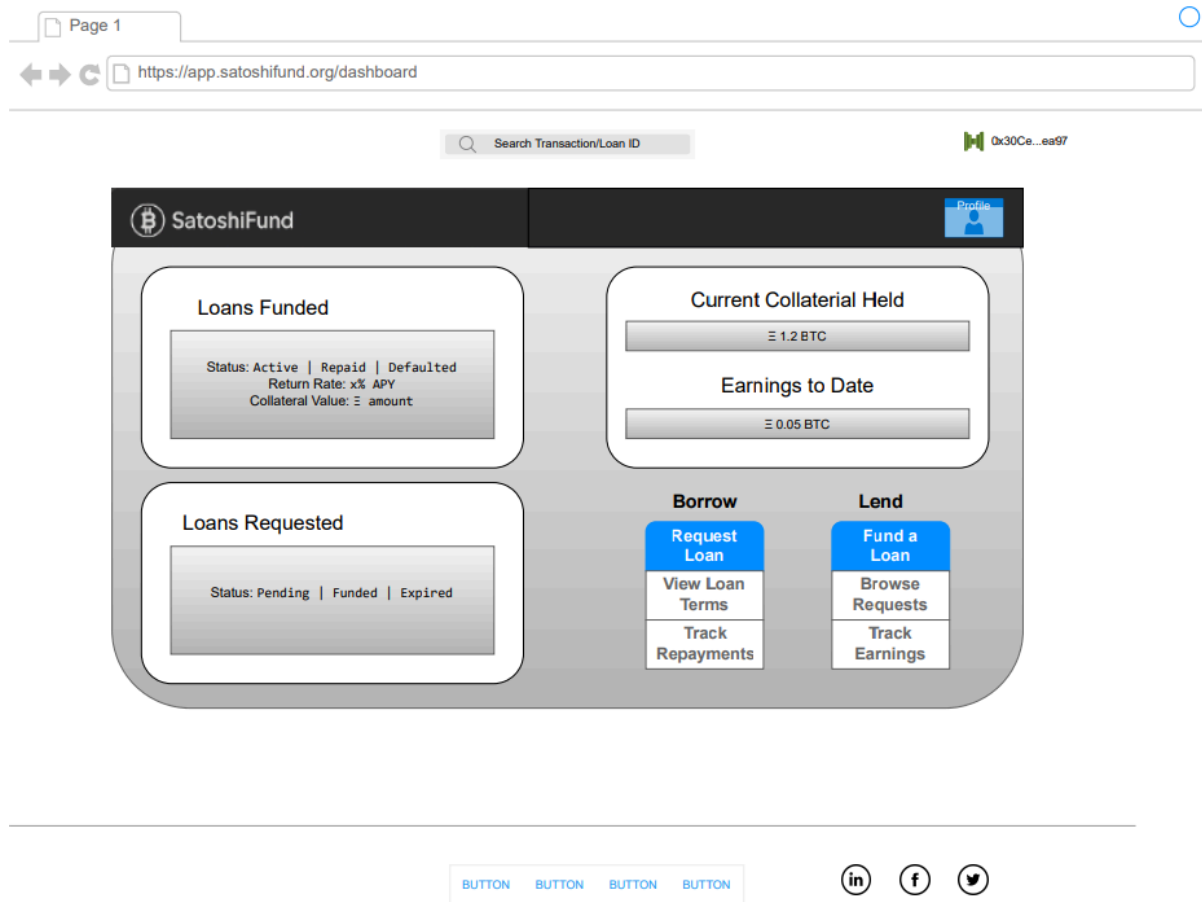


Mobile

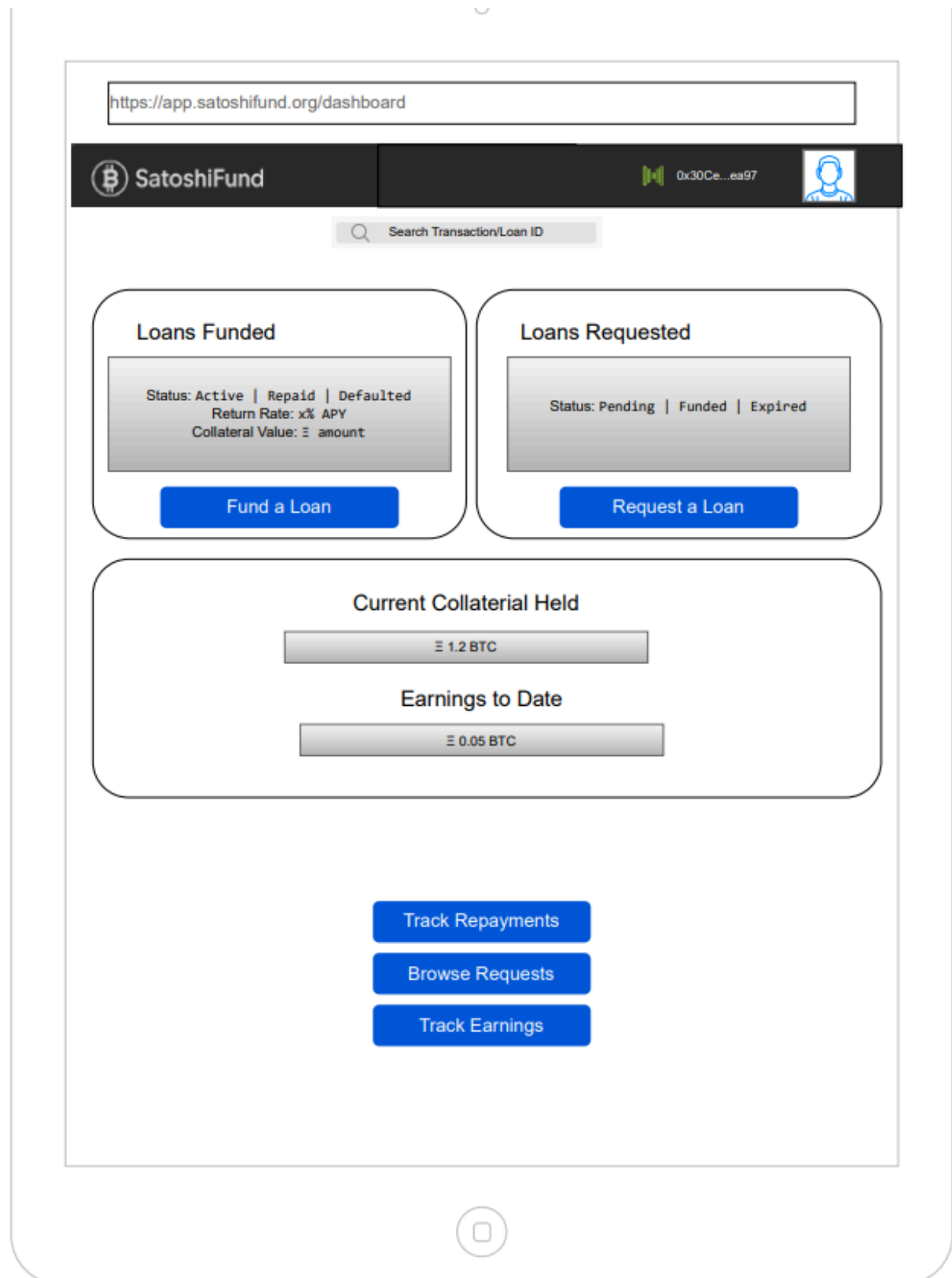


Dashboard (User)

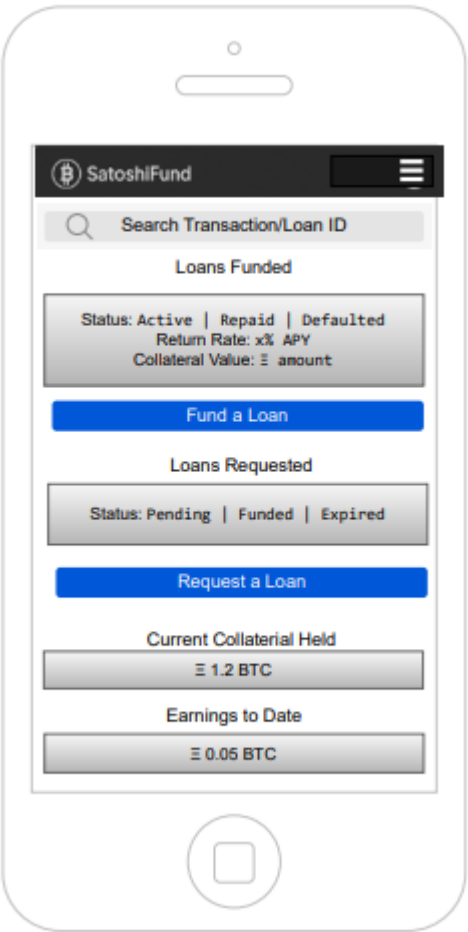
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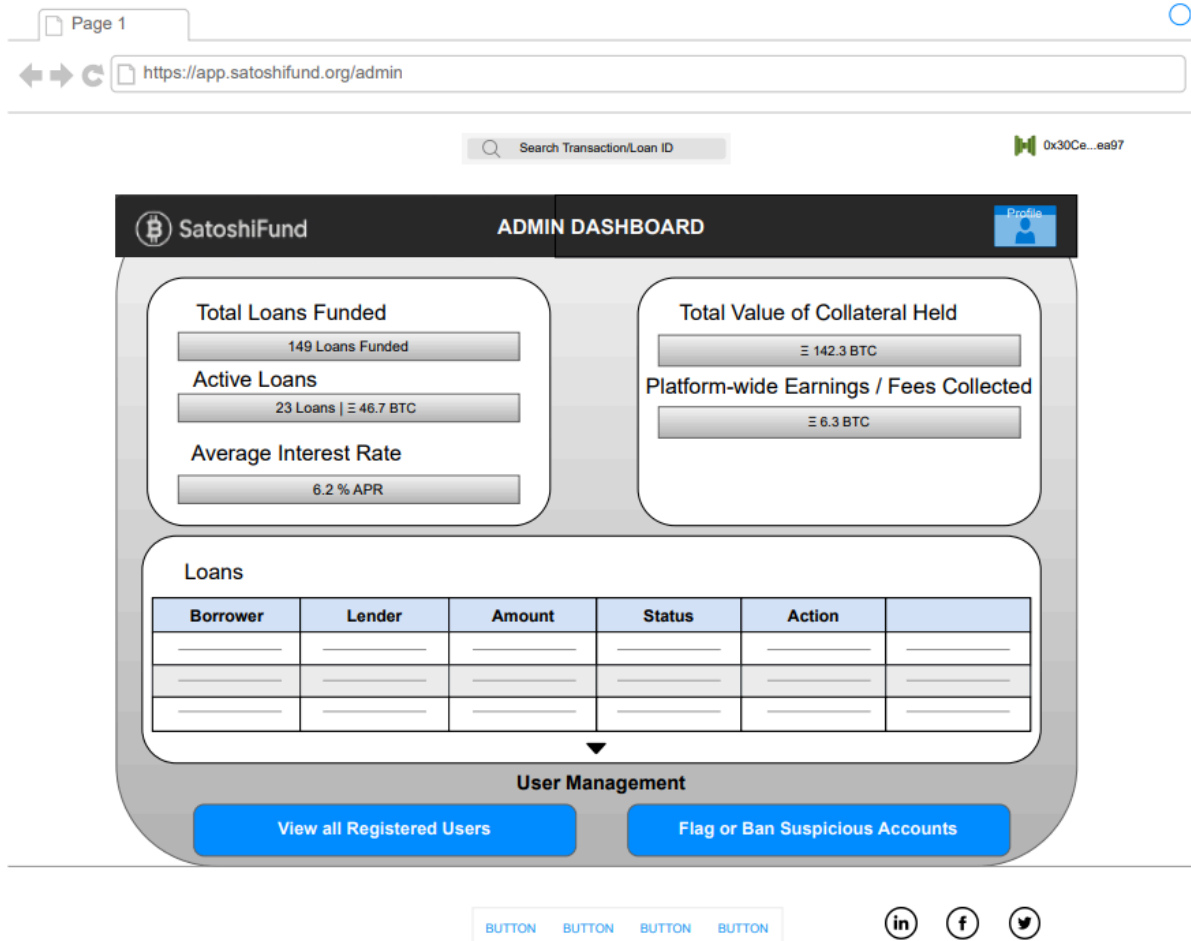


Mobile

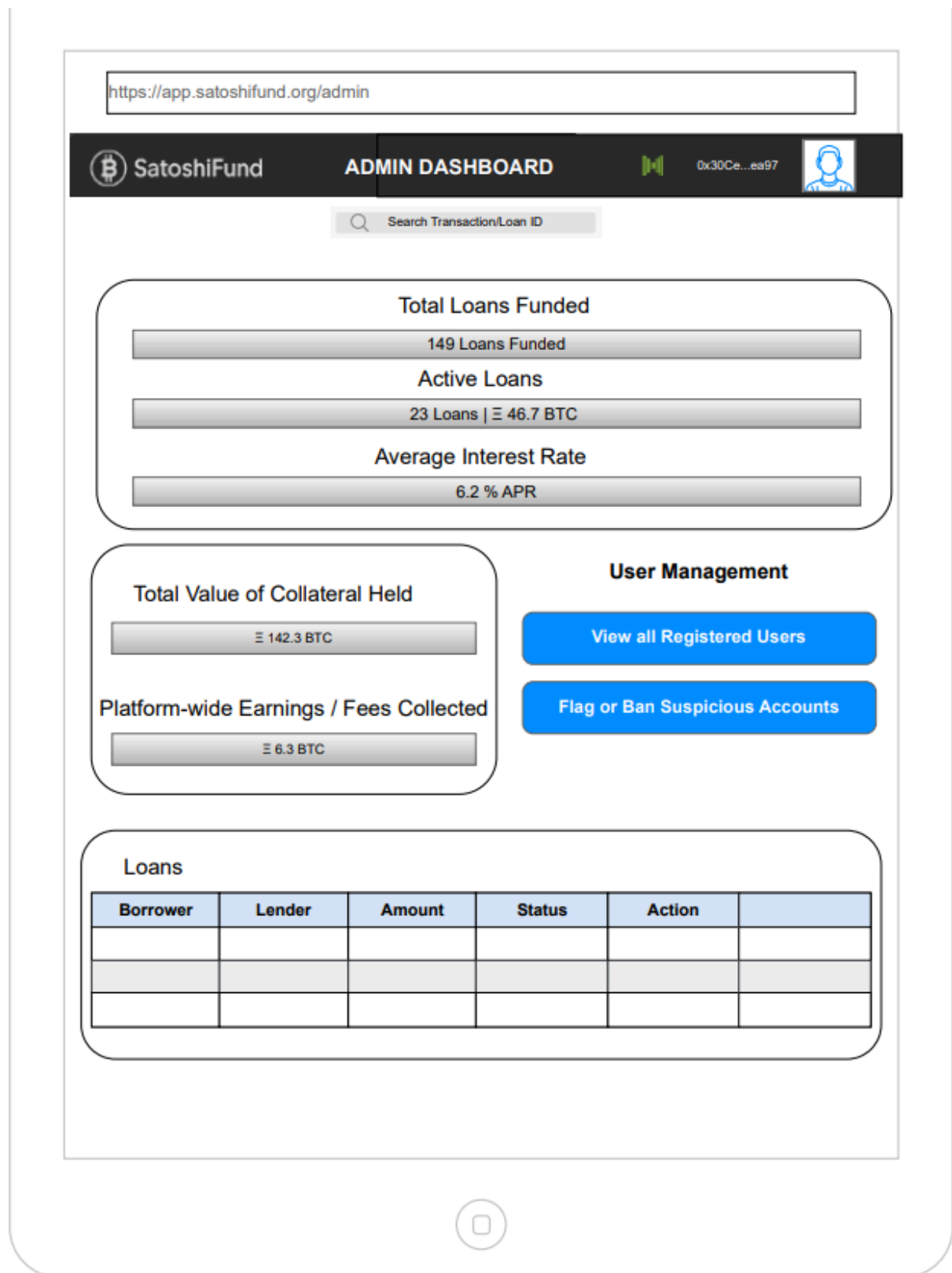


Dashboard (Admin)

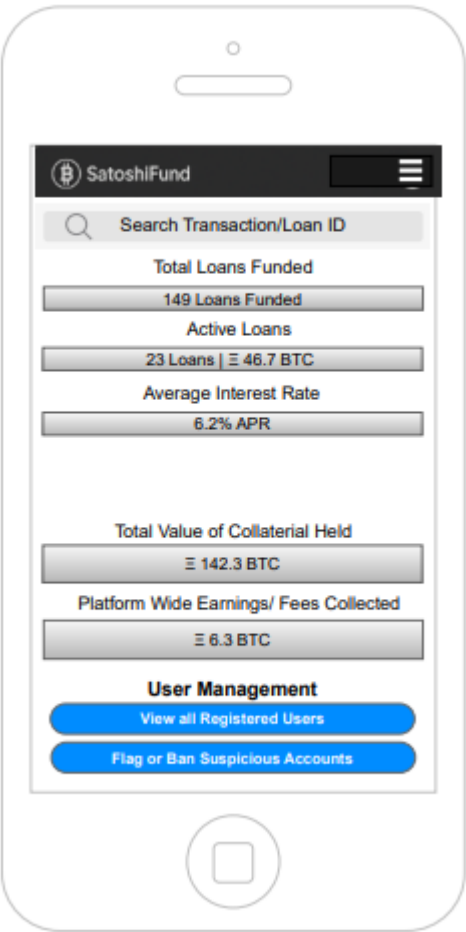
Desktop



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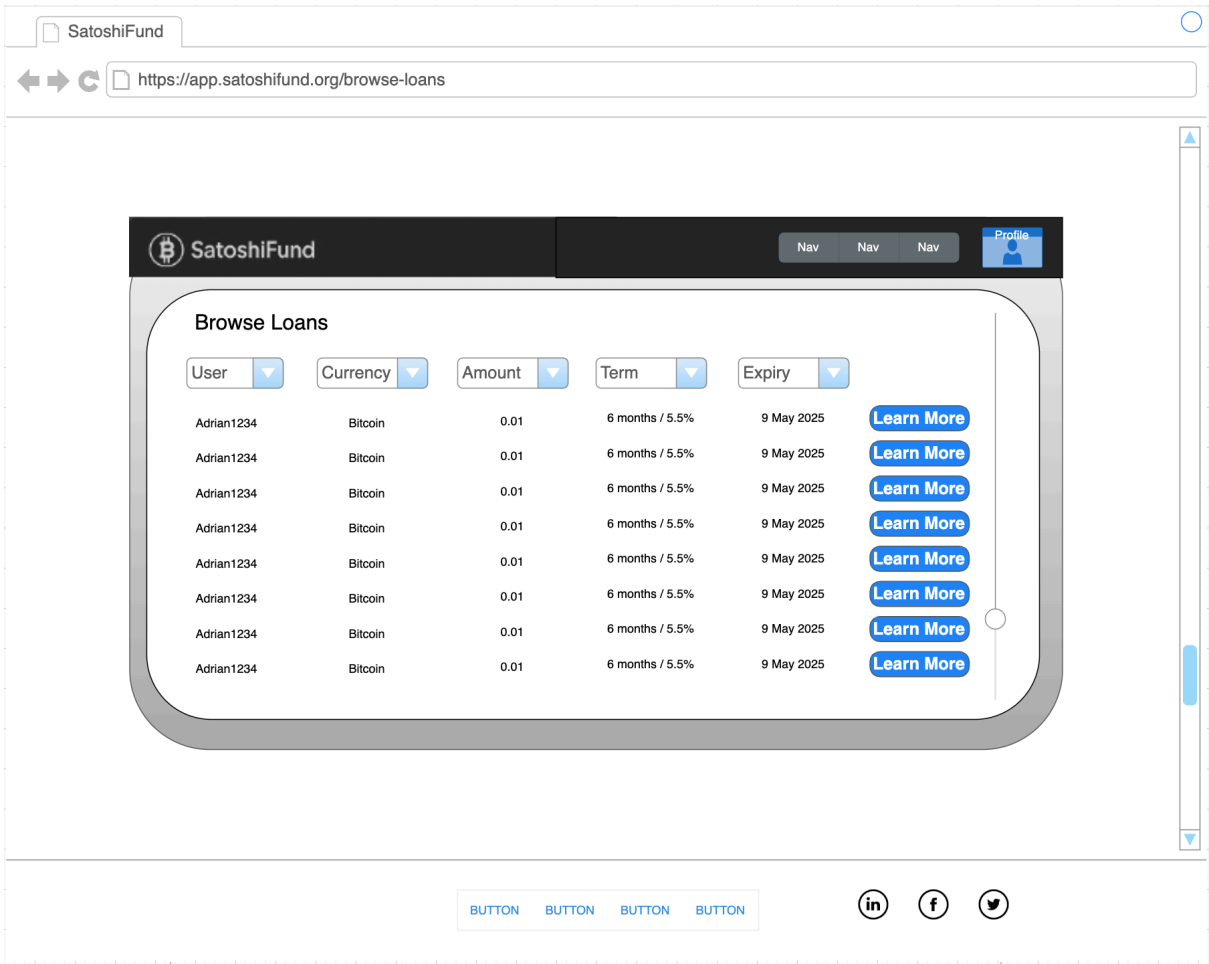


Mobile

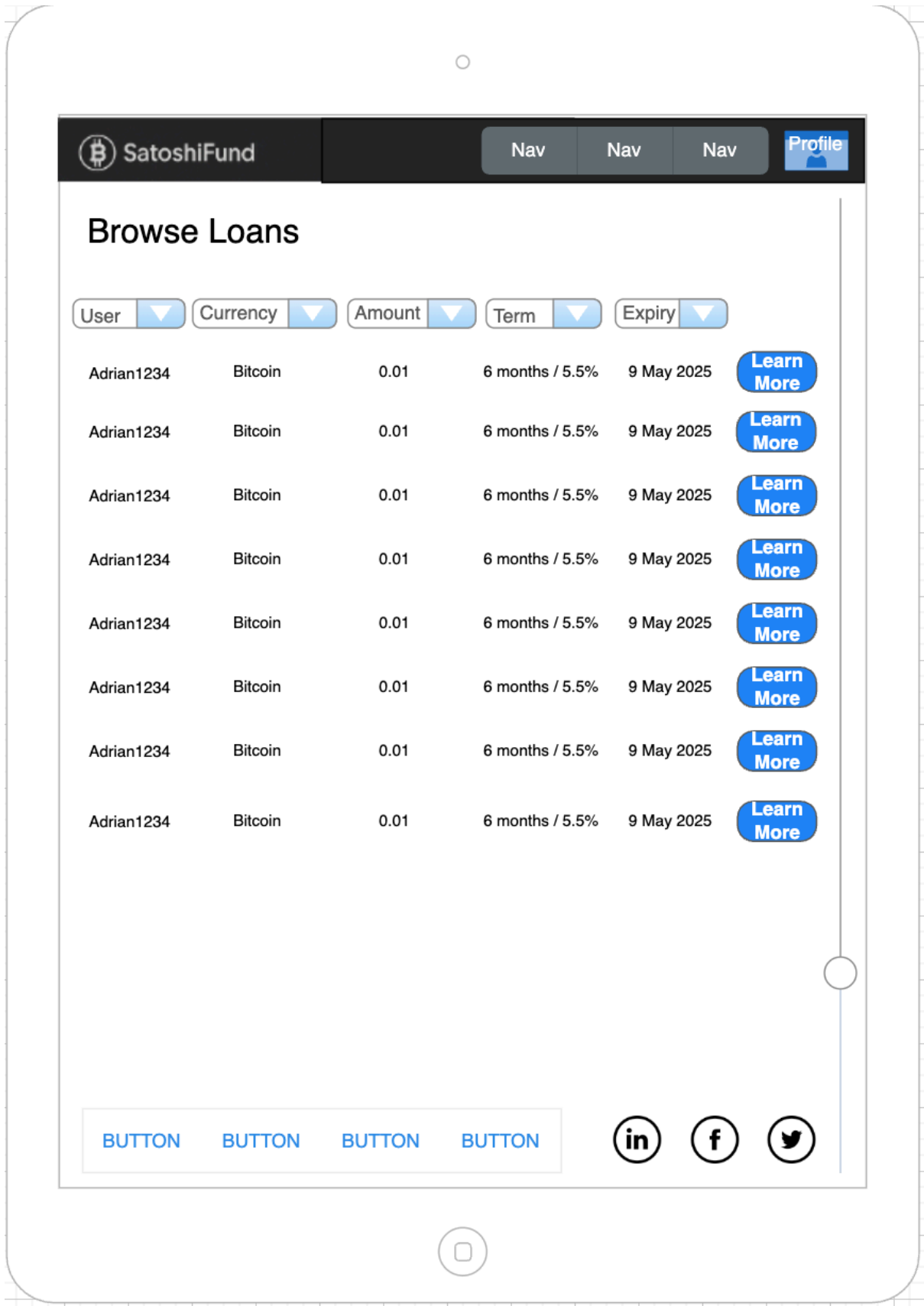


Browse Loans

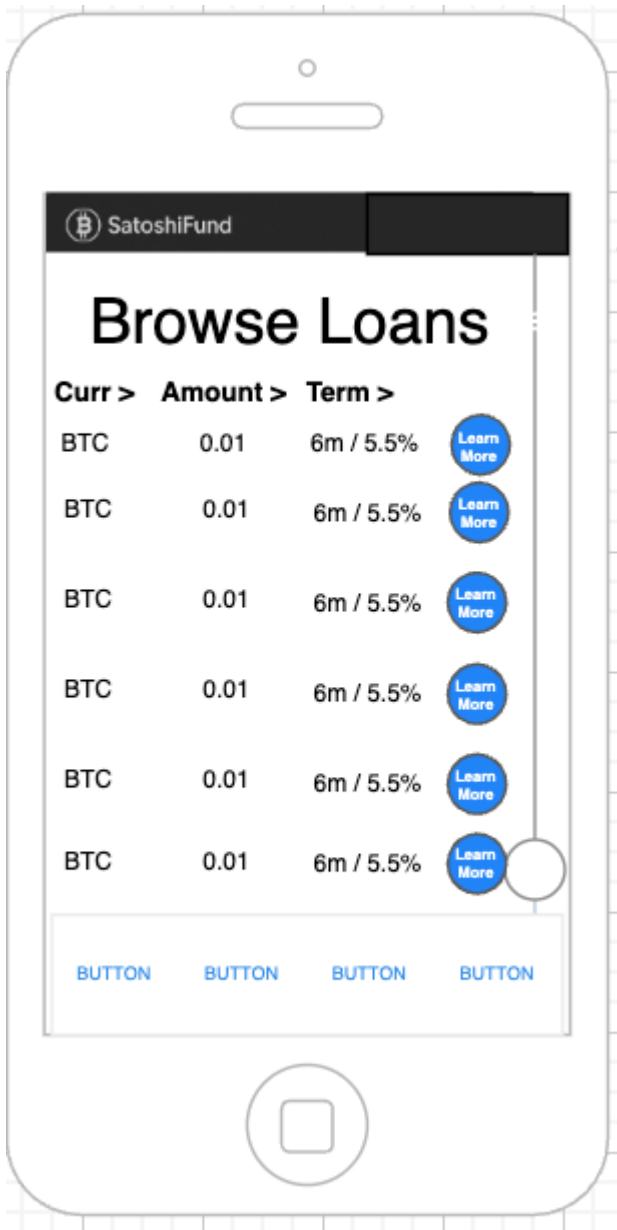
Desktop



Tablet



Mobile



Request A Loan

Desktop

Page 1

https://app.satoshifund.org/dashboard

Search Transaction/Loan ID

0x30Ce...ea97

SatoshiFund

Request a Loan

Profile

Requested Loan Amount

-Loan Amount -

Term Length

Select Term

Cryptocurrency

Select Currency

Submit Request

Collateral Information

- Estimated Value (USD)

- Description

BUTTON

BUTTON

BUTTON


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Tablet

https://app.satoshifund.org/dashboard

 SatoshiFund

Request a Loan

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Search Transaction/Loan ID

Requested Loan Amount

-Loan Amount -

Term Length


Select Term

Cryptocurrency

Select Currency

Submit Request

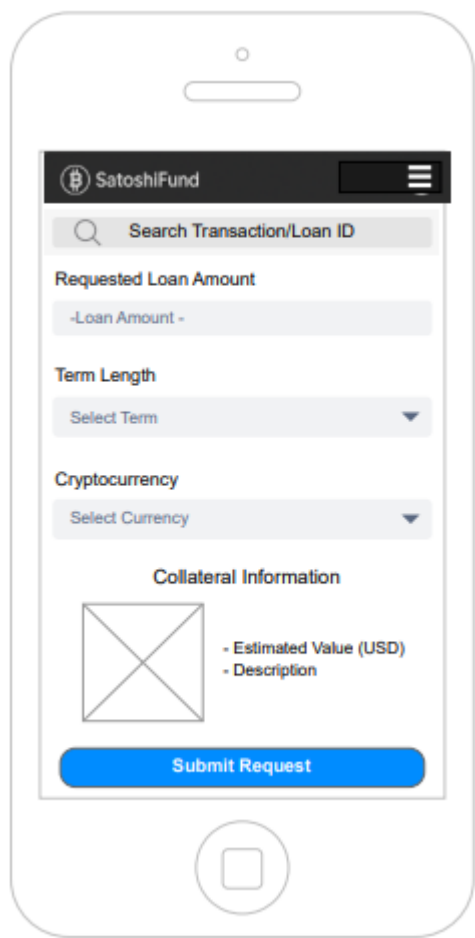
Collateral Information



- Estimated Value (USD)

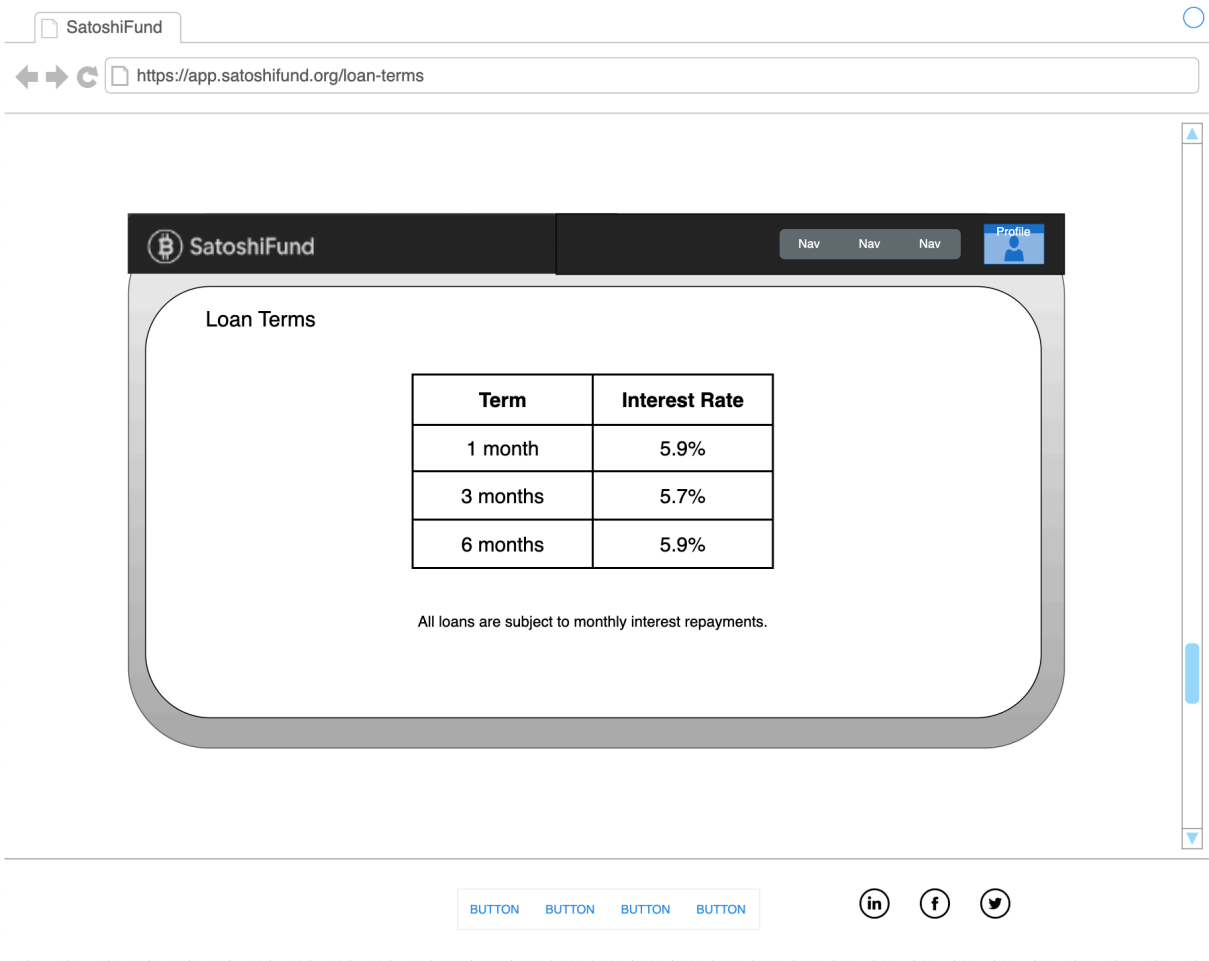
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Mobile

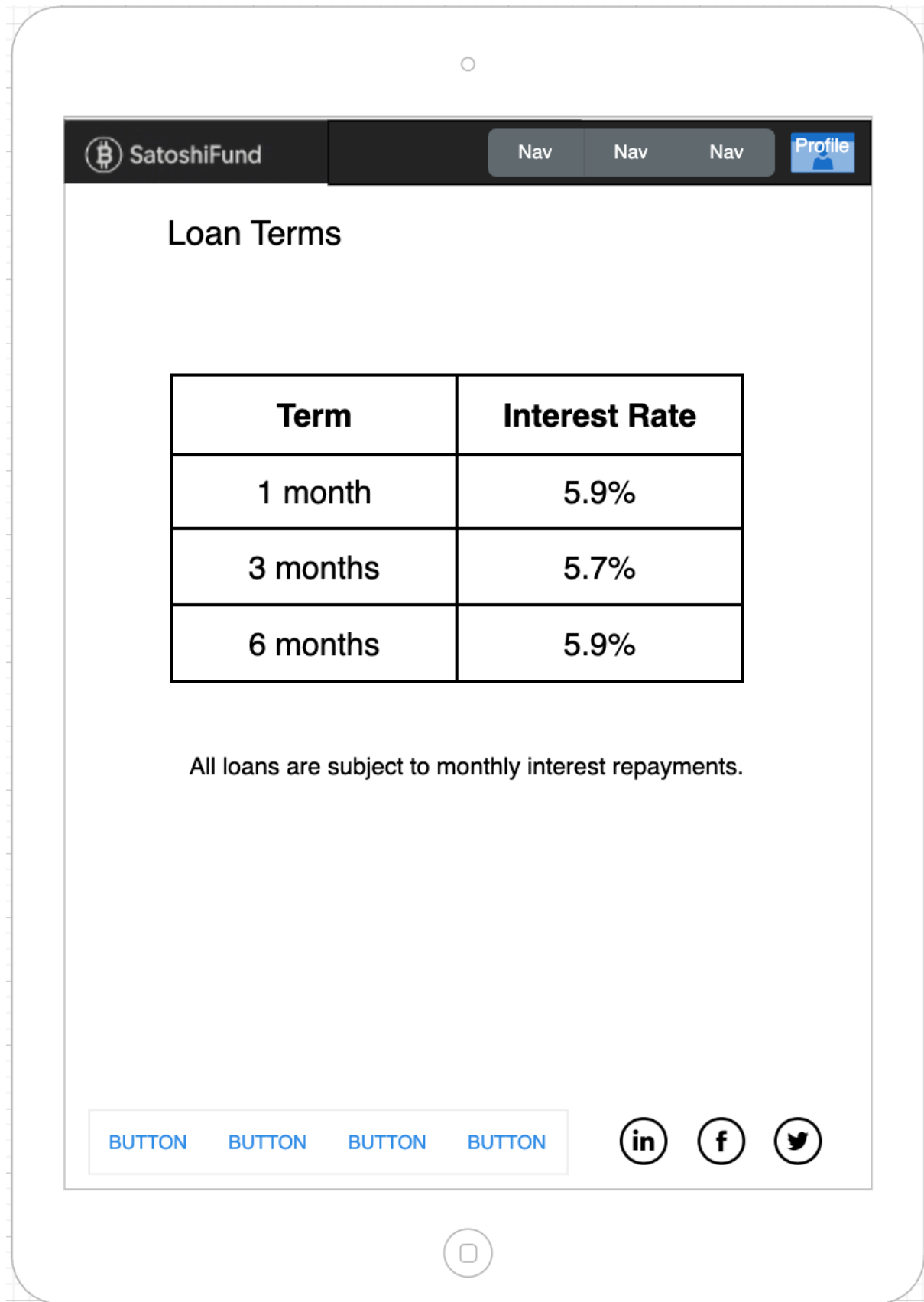


Loan Terms

Desktop



Tablet

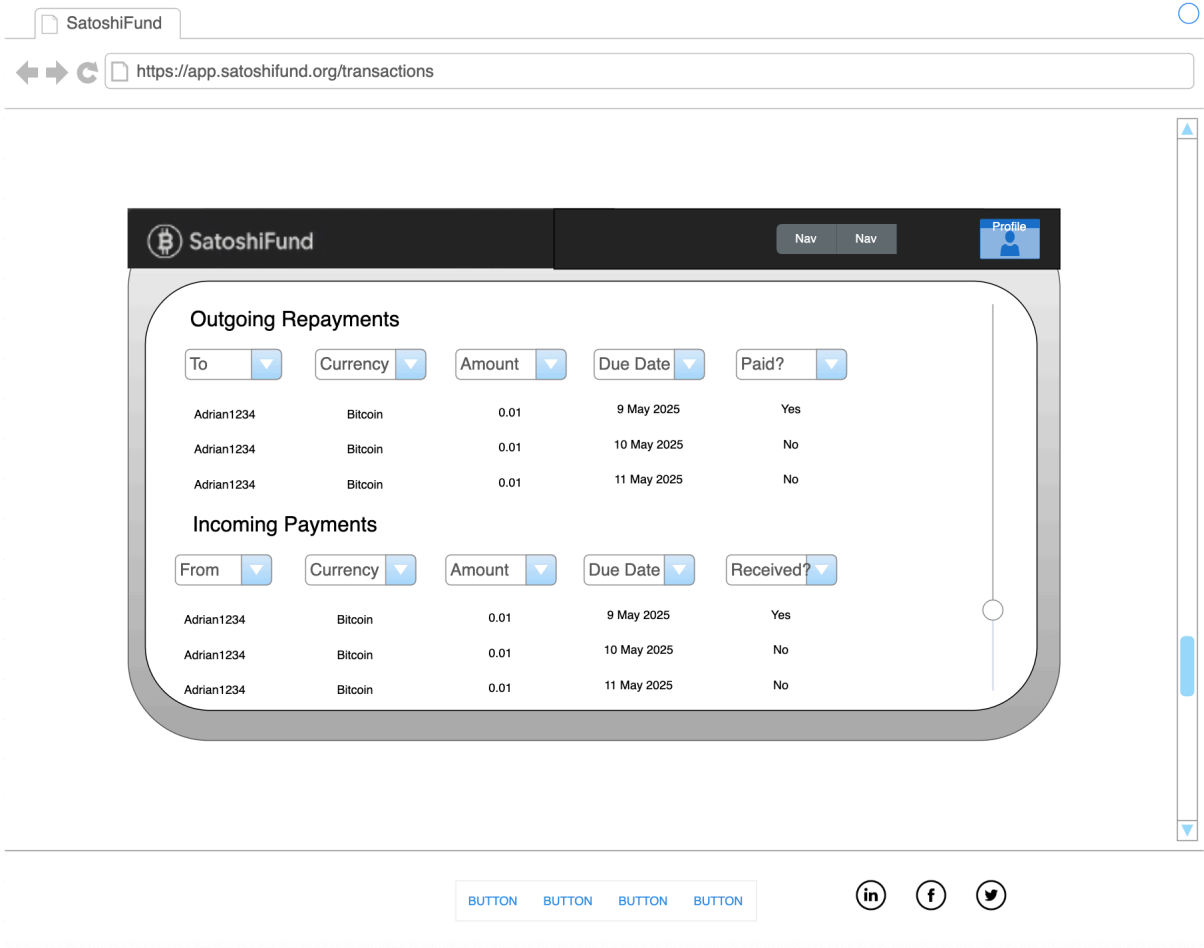


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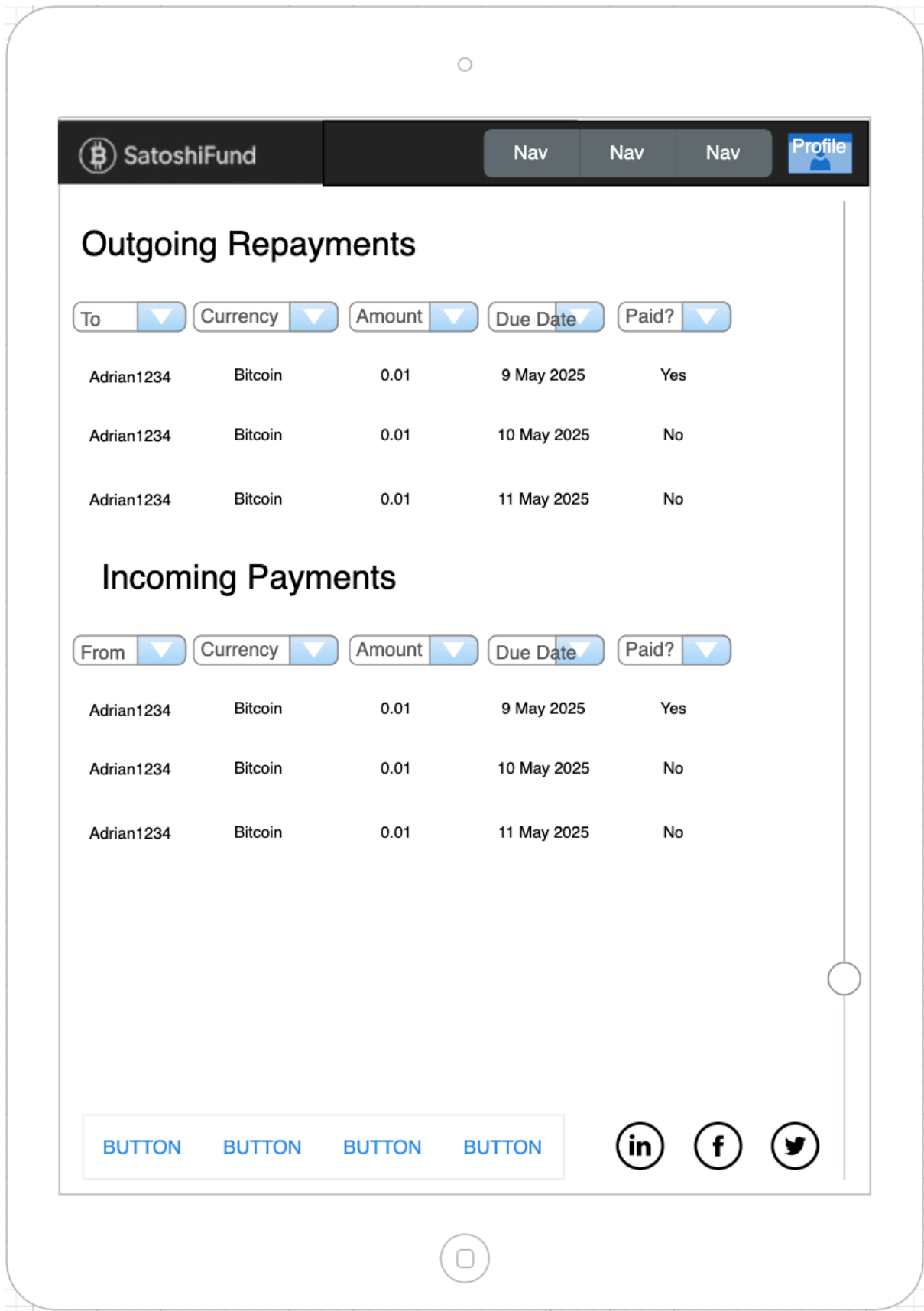


Transactions

Desktop



Tablet



Mobile

