GUJARAT TECHNOLOGICAL UNIVERSITY

University Area, Ahmedabad
Affiliated

L.D. College of Engineering

Project Report on

KEYGUARD

Under subject of
DESIGN ENGINEERING – II B (3160001)
B. E. Semester – VI
Electronics and Communication Engineering
Submitted By: Team ID 771039

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Head of the Department

Academic Year (2024 -2025)

L. D. College of Engineering,

Electronics and Communication Engineering

CERTIFICATE

Date: 11/4/2025

This is to certify that the project entitled "KeyGuard" has been successfully carried out by

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under my guidance in fulfilment of the Degree of Bachelor of Engineering in Electronics and Communication Engineering – 6th Semester of Gujarat Technological University, Ahmedabad during the academic year 2024-2025.

Internal Guide
Prof. (Dr.) Madhusmita C. Sahoo
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Prof. (Dr.) C. H. Vithalani
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CANDIDATE'S DECLARATION

We have finished our project report entitled "KeyGuard" and submitted to our respective guide. We have done our work proficiently with utter preciseness and to the best of our knowledge.

First Candidate's Name : **Aryan Chudasama**
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ACKNOWLEDGEMENT

We would like to thank with respect all those who have provided us immense help and guidance during our project. We would like to thank our faculty guide **Prof. (Dr.) Madhusmita C. Sahoo** for providing vision about the system and for giving us and opportunity to undertake such a great challenging and innovative work. We are grateful for the guidance, encouragement, understanding, and insightful support given in the development process. We would like to extend our gratitude to **Prof. (Dr.) C. H. Vithalani,** Head of the EC Department, LD College of Engineering, Ahmedabad, for his continuous encouragement and motivation.

Last but not the least, we would like to mention here that we are greatly indebted to each and everybody who has been associated with our project at any stage but whose name does not find a place in this acknowledgement.

Yours sincerely,

Aryan Chudasama	(230283111005)
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ABSTRACT

The KeyGuard system is an innovative solution for secure key management, utilizing RFID technology to enhance accessibility and accountability. Aimed at efficient key control, the system employs RFID tags for cabinet access, displaying on the interface the keys assigned to an individual upon successful RFID authentication. Users can then select the desired keys, triggering a distinct LED blink & buzzer sound for identification.

The project involves a comprehensive approach to key security, seamlessly integrating user-friendly RFID interactions with a responsive display system. The system not only facilitates key retrieval but also ensures a transparent tracking mechanism, fostering a heightened sense of responsibility among users. The LED & buzzer auditory signalling provides a clear visual & auditory indicator, streamlining the process of key pick-up and return.

By amalgamating RFID technology, intuitive user interfaces, and dynamic feedback, the KeyGuard system not only enhances the efficiency of key management but also establishes a robust framework for monitoring and accountability. This abstract encapsulates the project's objectives, operational procedures, and the pivotal role of RFID in transforming conventional key management practices.

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CHAPTER 1

1.1 Introduction

This project presents the development of an innovative Keyguard system, leveraging RFID technology to revolutionize traditional key management processes. The system employs RFID tags for secure unlocking and locking of cabinets containing keys, ensuring a streamlined and efficient approach to key access.

The KeyGuard system enhances user experience by displaying a personalized key assignment interface upon RFID card authentication. Users are presented with a clear list of keys associated with their access credentials, empowering them to make informed selections. The system utilizes a dynamic display to showcase real-time key allocation, fostering transparency in the key management process.

In addition to the visual interface, the project incorporates a tactile feedback mechanism through LED indicators. Upon selecting keys, the corresponding LED lights blink, providing users with a tangible confirmation of their choices. This user-friendly feature enhances the overall accessibility and usability of the Keyguard system.

Furthermore, the system ensures accountability by logging key transactions. Each instance of unlocking or locking the cabinet is recorded, establishing a comprehensive audit trail. This not only promotes security but also facilitates monitoring and reporting for administrative purposes.

The KeyGuard system addresses the need for a sophisticated and intelligent key management solution, catering to diverse environments such as offices, facilities, and institutions. Its RFID-based authentication ensures a robust and secure access control mechanism, mitigating the risk of unauthorized key access.

In conclusion, this project introduces a cutting-edge RFID-Based Intelligent Key Management System that redefines conventional key management paradigms. With its user-centric interface, tactile feedback, and robust security features, the Keyguard system emerges as a pioneering solution for efficient and accountable key access in various organizational settings.

1.2 Problem definition

The current key-based access control systems pose several challenges, including the risk of unauthorized access, the inconvenience of managing physical keys, and the inability to track entry and exit times accurately. The need for a more secure, user-friendly, and technologically advanced solution has led to the identification of the following key problems:

A. **Security Concerns:**

- Traditional keys can be easily duplicated, leading to the risk of unauthorized access.
- Lost or stolen keys can compromise the security of the controlled environment.

B. **Inconvenience and Management Issues:**

- Physical keys require manual handling and can be easily misplaced.
- Managing a large number of keys becomes cumbersome and may lead to organizational inefficiencies.

C. **Lack of Access Tracking:**

- Traditional systems often lack the ability to accurately track entry and exit times.
- The absence of real-time monitoring makes it challenging to respond promptly to security incidents.

D. **Need for Modernization:**

- In an era of technological advancements, there is a growing need to replace outdated access control systems with more sophisticated and reliable solutions.

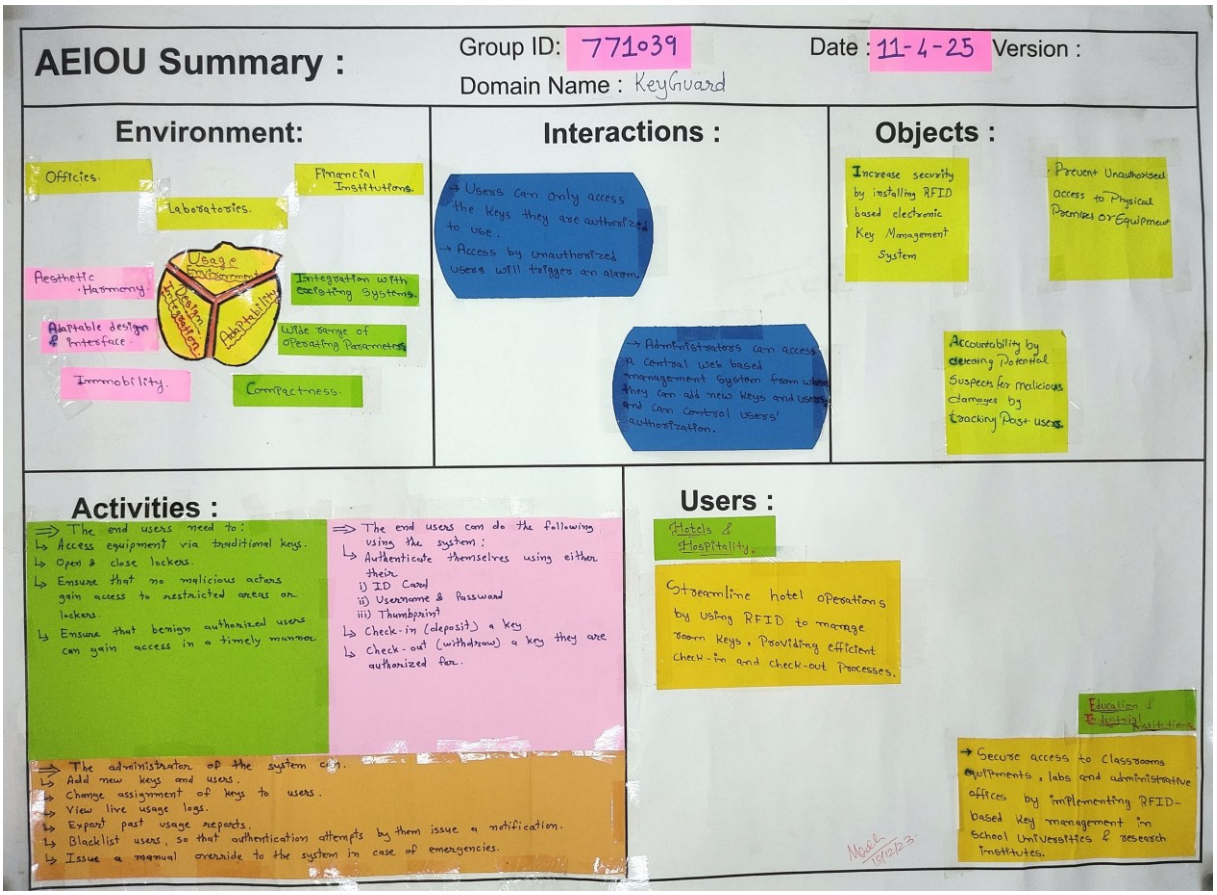
1.3 Importance of domain

The domain of an RFID Key Guard System is crucial for various reasons, as it defines the context and environment in which the system operates. The importance of the domain lies in its impact on the design, implementation, and effectiveness of the RFID Key Guard System. Here are some key aspects of the importance of the domain:

- **Security Requirements:** Different domains have varying security needs. For example, the security requirements for a residential RFID Key Guard System may differ from those of a corporate office or a government facility. Understanding the specific security concerns within a given domain is crucial for tailoring the RFID Key Guard System to meet those requirements effectively.
- **User Interaction and Experience:** The user interaction and experience requirements can vary based on the domain. A system implemented in a commercial environment may need to accommodate a large number of users, whereas a residential system may prioritize simplicity and ease of use for homeowners. Understanding the user needs within the domain helps in designing an interface that is user-friendly and meets the expectations of the users.
- **Integration with Existing Infrastructure:** The domain influences the existing infrastructure and technology landscape. The RFID Key Guard System needs to integrate seamlessly with the current access control systems and technologies present in the domain. Understanding the infrastructure helps in avoiding conflicts, ensuring compatibility, and facilitating a smoother transition to the new system.
- **Compliance and Regulations:** Different domains are subject to specific regulations and compliance standards related to security and privacy. Adhering to these regulations is critical to the success and acceptance of the RFID Key Guard System. Understanding the legal and regulatory environment within the domain ensures that the system is designed and implemented in compliance with applicable laws.
- **Scale and Volume:** The scale and volume of the deployment may vary based on the domain. For instance, an industrial setting may require a system that can handle a large number of access points and users simultaneously. Understanding the scale and volume requirements within the domain is essential for designing a system that is scalable and can handle the anticipated load.

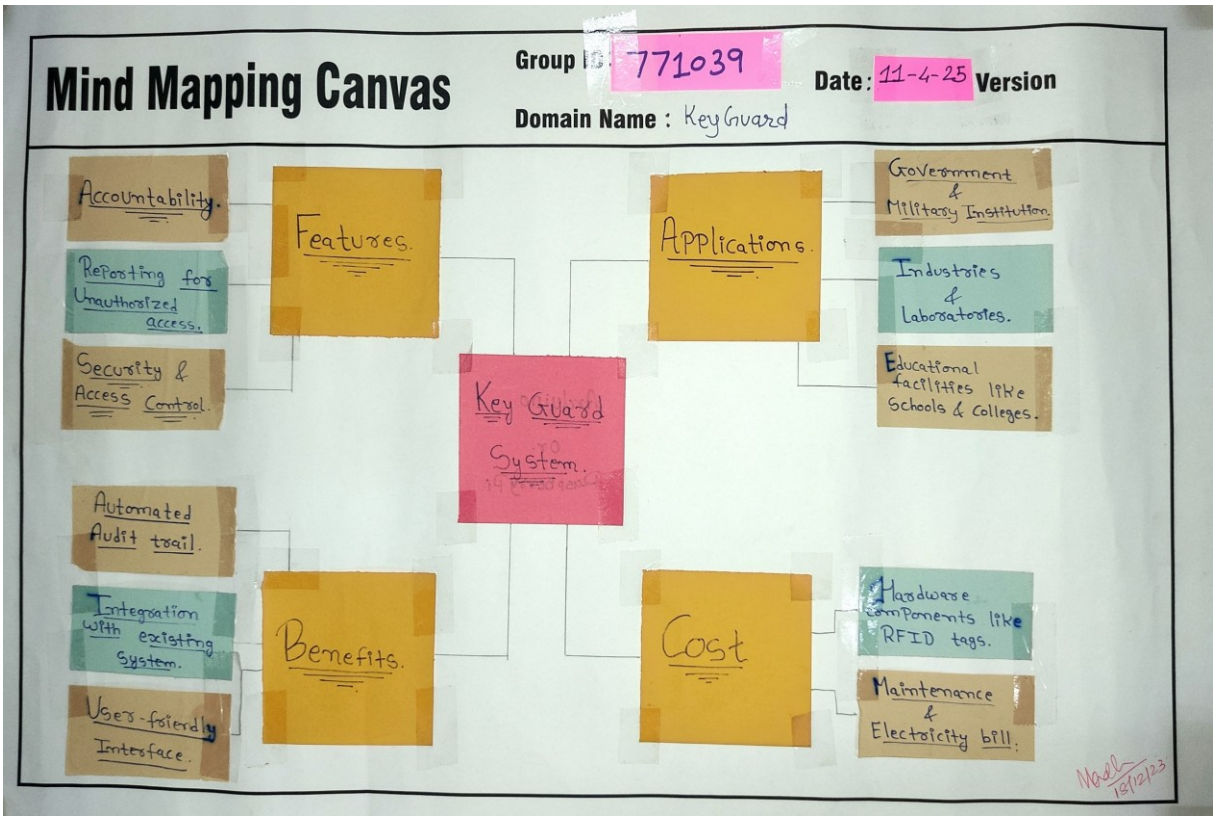
- **Risk Assessment and Mitigation:** Each domain comes with its own set of potential risks and threats. Conducting a thorough risk assessment within the specific domain helps in identifying potential vulnerabilities and developing mitigation strategies. The RFID Key Guard System can then be tailored to address the specific risks relevant to the domain.
- **Customization and Adaptability:** The domain influences the need for customization and adaptability of the RFID Key Guard System. A system designed for a specific domain should be flexible enough to accommodate changes in requirements and technologies within that domain over time.

CHAPTER 2: AEIOU SUMMARY



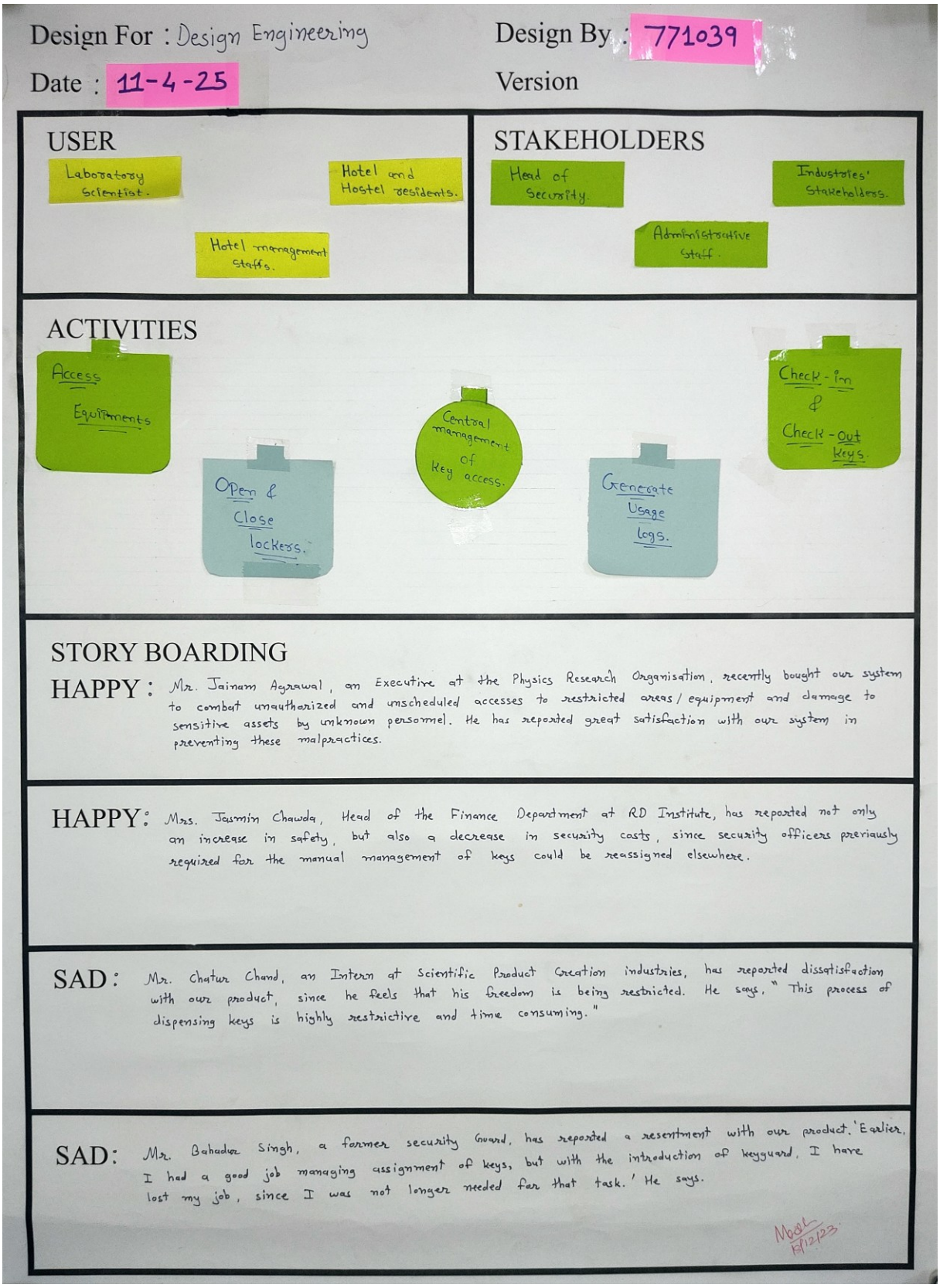
- **A - Activities:** Identify key activities that the users need to perform such as RFID scanning, user authentication, access control.
- **E - Environment:** Consider the physical and digital environment where the RFID key guard will be implemented, including potential security threats
- **I - Interactions:** Define user interactions with the RFID key guard, ensuring a seamless and secure experience.
- **O - Objects**: List key objects involved, like RFID tags, authentication mechanisms, and the physical guard structure.
- **U - Users:** Identify user roles and their responsibilities in using the RFID key guard, emphasizing security protocols.

CHAPTER 3: MIND MAPPING



The Mind Map Canvas specifies the Features, Benefits, Applications & Costs/ Downsides of our system. Mind mapping is to present all these topics or points in the form of diagram, drawing or any other form. Through this mind mapping canvas our intention will be clear about our topic and what we must do further. Mind mapping canvas is for easy understanding of the domain.

CHAPTER 4: EMPATHY CANVAS



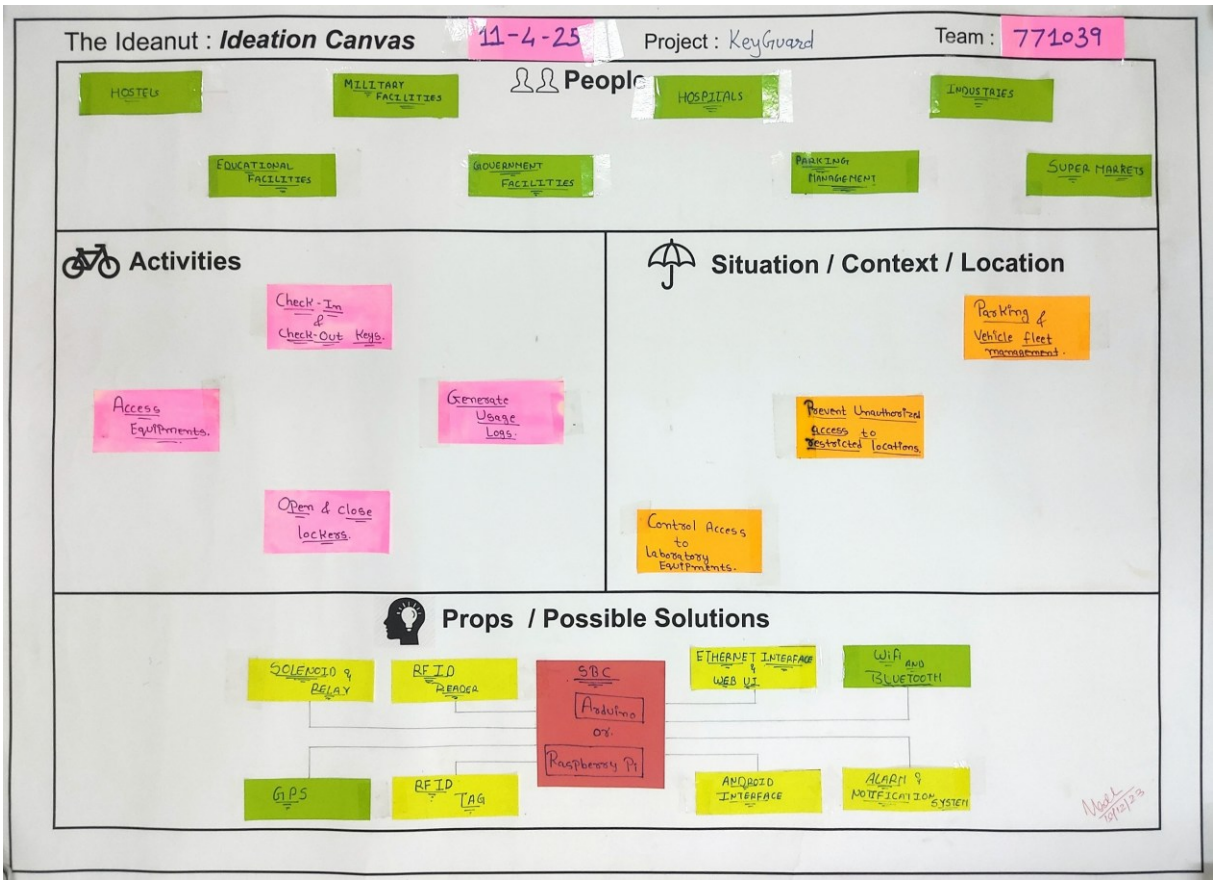
HAPPY: Mr. Jainam Agrwal, an Executive at the Physics Research Organisation, recently bought our system to combat unauthorized and unscheduled access to restricted areas/equipment and damage to sensitive assets by unknown personnel. He has reported great satisfaction with our system in preventing the malpractices

HAPPY: Mrs. Jasmin Chawda, Head of the Finance Department at RD Institute, has reported not only increase in safety but also a decrease in security costs, since security officers previously required for the manual management of keys could be reassigned elsewhere.

SAD: Mr Chatur Chand, an Intern at Scientific Product Creation Industries, has reported dissatisfaction with our product since he feels that his freedoms are being restricted. He says, "This process of dispensing keys is highly restrictive and time consuming."

SAD: Mr. Bahadur Singh, a former security guard, has reported a resentment with our product. “Earlier I had a good job managing the assignment of keys, but with the introduction of KeyGuard, I have lost my job, since I was no longer needed for that task” he says.

CHAPTER 5: IDEATION CANVAS



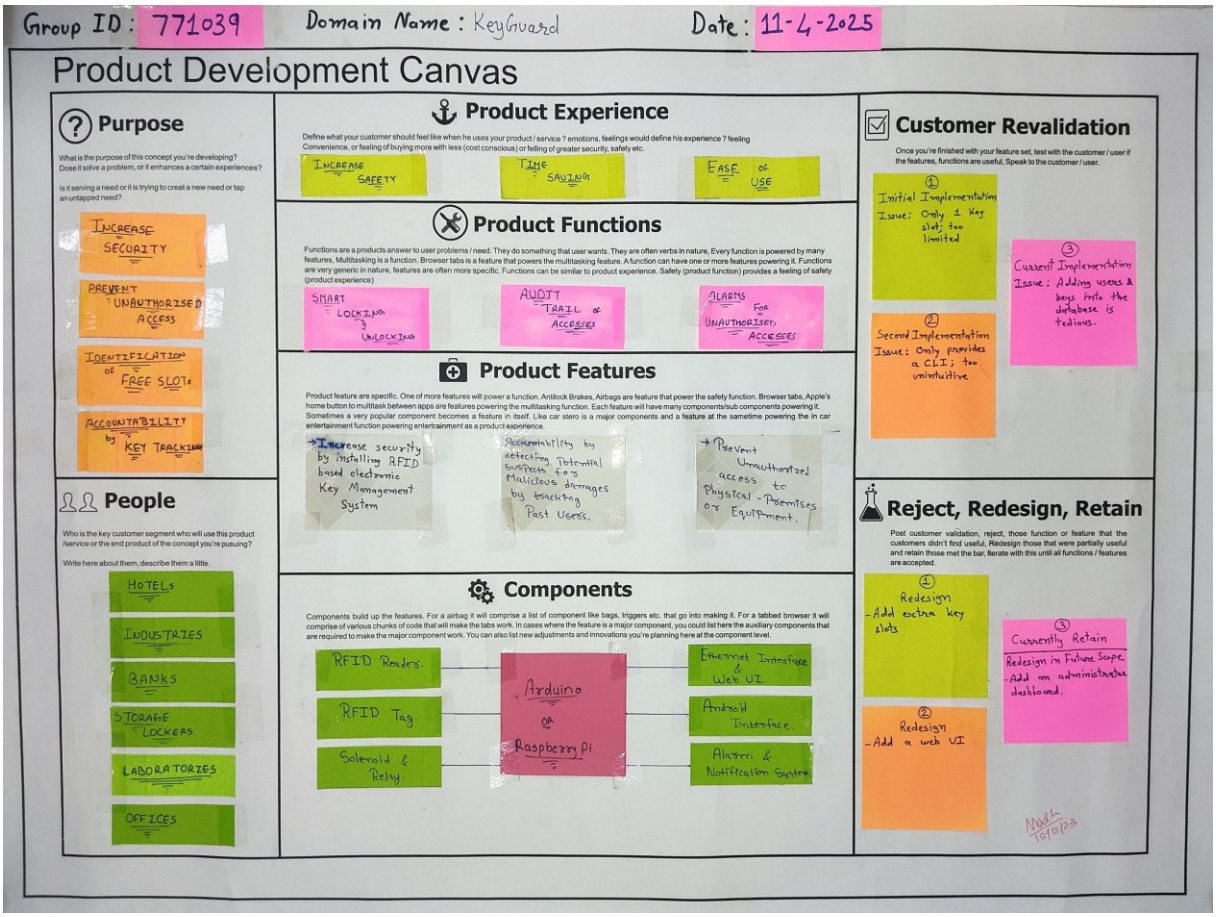
People: Hostels, Education facilities, Military facilities, Government facilities, Hospitals, Parking management, Industries, Super market.

Activities: Check in & Check out keys, access equipment, generating usage logs, open & close lockers.

Situation: Parking & vehicle fleet management, prevent unauthorized access to restricted location , control access to laboratory equipment.

Possible Solutions: Solenoid & Relay, RFID reader, GPS, RFID tags, Ethernet interface & web UI, WIFI and Bluetooth, android interface, alarm & notification system.

CHAPTER 6: PRODUCT DEVELOPMENT CANVAS



Purpose: increase security, prevent unauthorised access, identification of free slots, accountability by key trekking.

People: Hotels, industries, Banks, Storage lockers, Laboratories, offices.

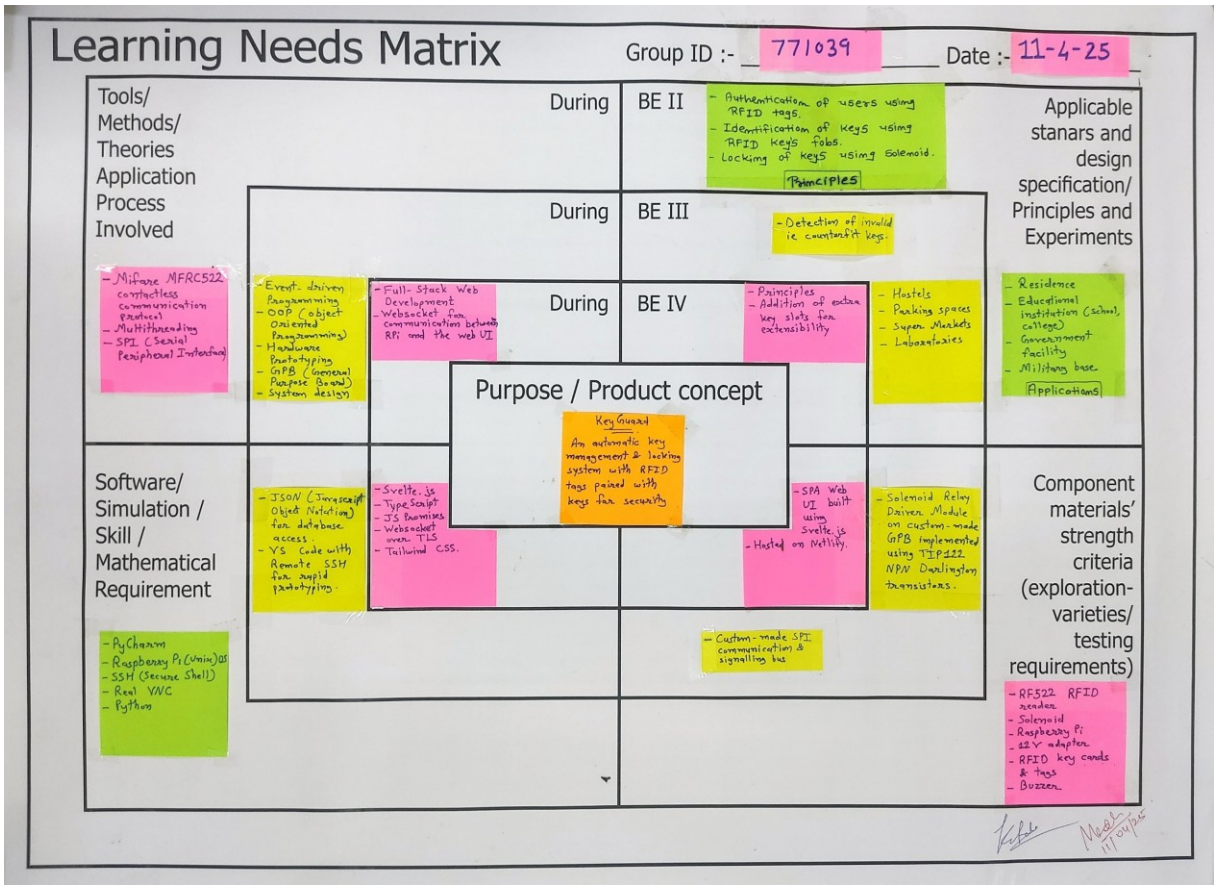
Product Experience: Increase safety, time saving and ease of usage.

Product Functions: smart locking and unlocking, audit trail and accesses, alarms for unauthorised access.

Product Features: increase security by installing RFID based electronic key management system, accountability by detecting potential suspects for malicious damage by trekking past users, prevent unauthorised access to physical-premises or equipment.

Components: Solenoid & relay, RFID reader, GPS, RFID tags, Ethernet interface & Web UI, WIFI and Bluetooth, Android Interface, Alarm & Notification System, Raspberry PI.

CHAPTER 7: LNM CANVAS



The LNM (Learning Needs Model) Canvas helps identify the learning requirements of the system being designed.

Applications:

- Residences, Educational Institutions (Schools & Colleges), Government facilities, Military bases
- Hostels, Parking Spaces, Super Markets, Laboratories

Principles:

- Authentication of users using RFID tags.
  Identification of keys using RFID tags.
  Locking of keys using solenoid.
- Detection of invalid i.e. counterfeit keys.
- Addition of an extra key slot for extensibility.

Components:

- RF522 RFID reader, Solenoid, Raspberry Pi, 12V Adapter, RFID cards & tags, Buzzer;

- Solenoid Relay Driver Module on custom GPB (General Purpose Board), Custom made SPI communication bus.
- SPA Web UI built using Svelte.js hosted on Netlify

Software:

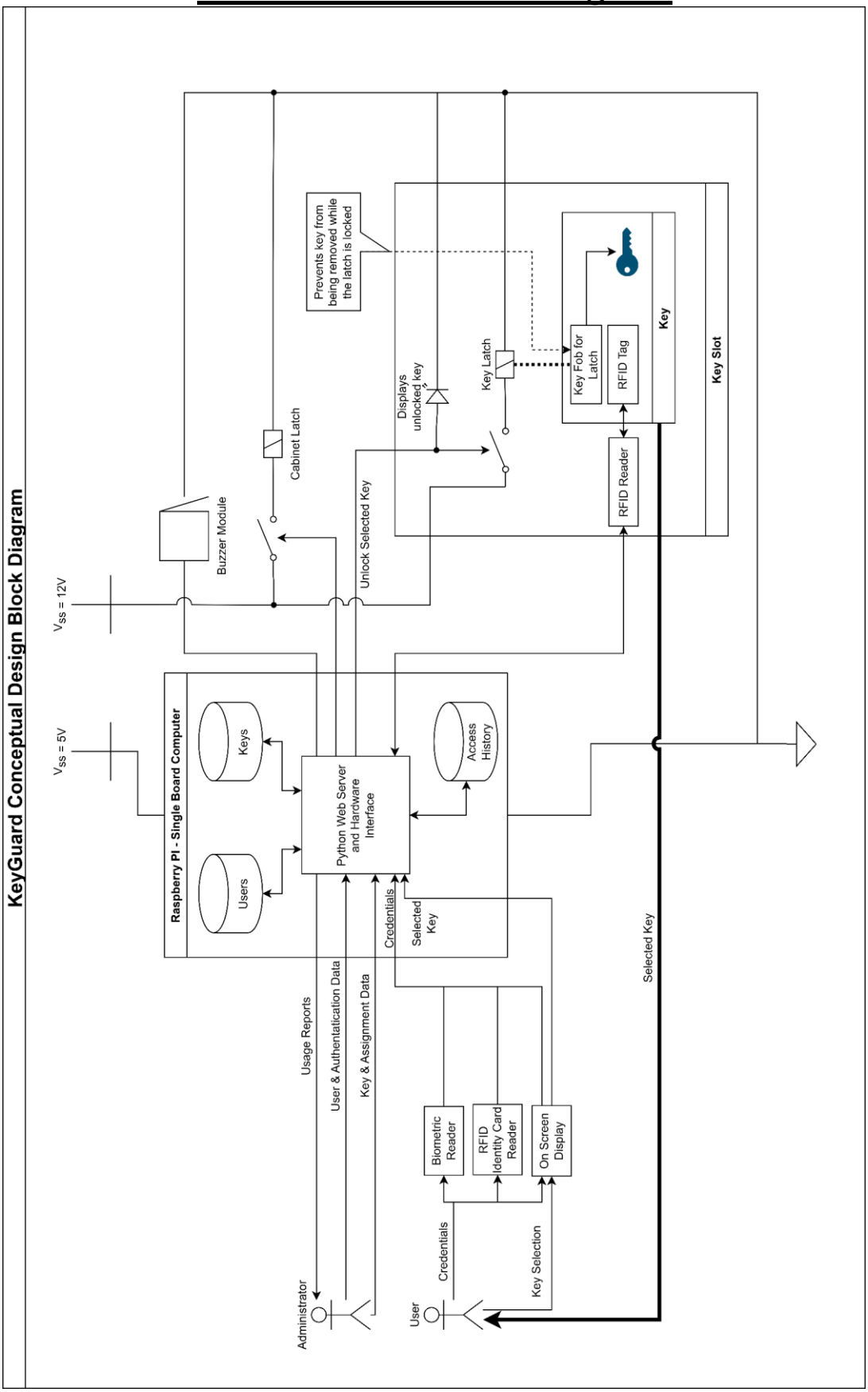
- Raspberry Pi (Unix) OS, Python, PyCharm, SSH (Secure Shell), RealVNC
- JSON (JavaScript Object Notation) for Database access, VS Code with Remote-SSH
- Svelte.js, TypeScript, JS Promises, WebSockets over TLS, Tailwind CSS

Tools:

- SPI (Serial Peripheral Interface), Mifare MRFC522 contactless communication protocol, Multithreading
- Event-driven programming, OOP, Hardware Prototyping & System Design, GPB
- Full-Stack Web Development
- WebSocket for communication between the Raspberry Pi and the Web UI.

CHAPTER 8: PROTOTYPE

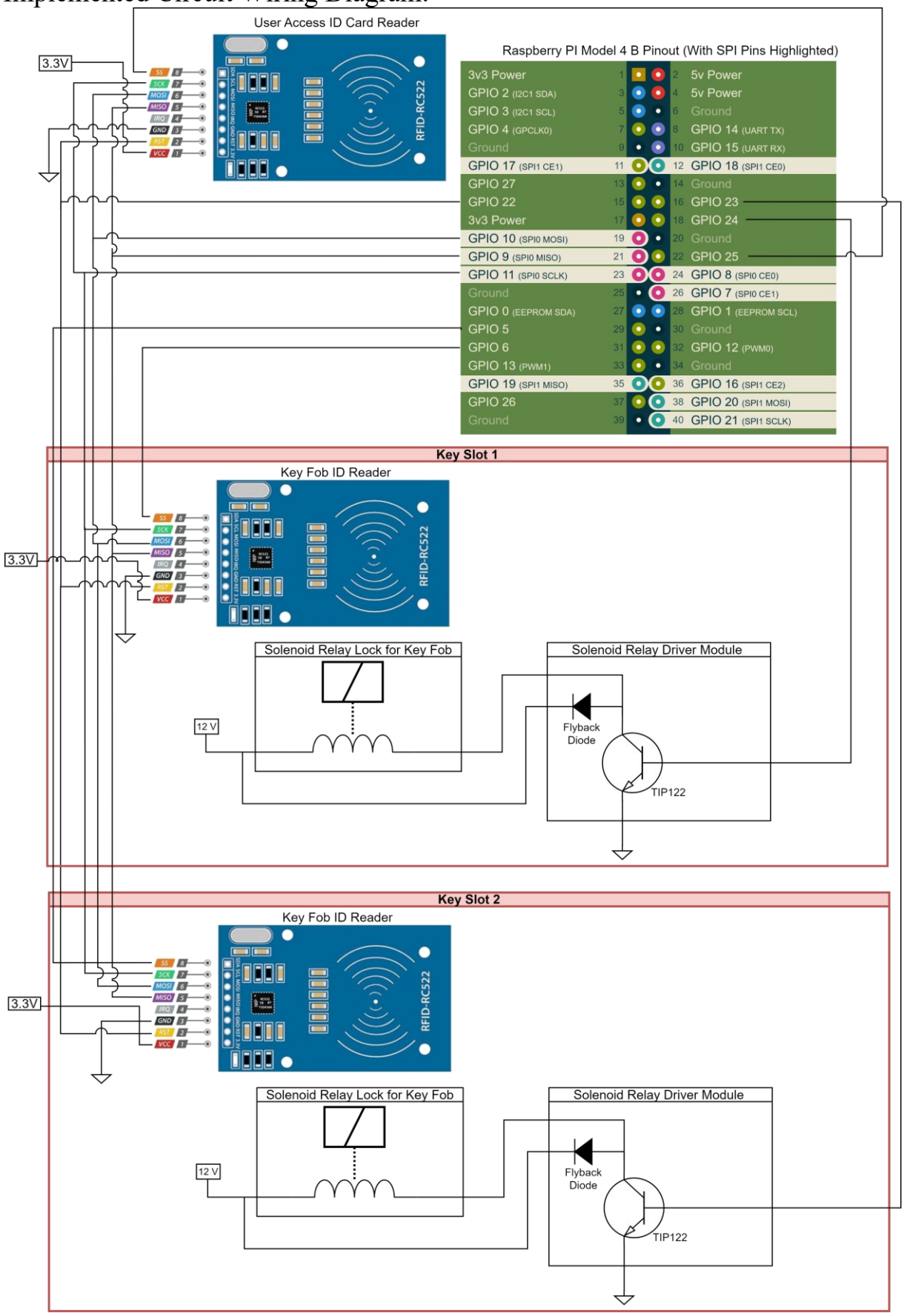
8.1: Idealized Block Diagram



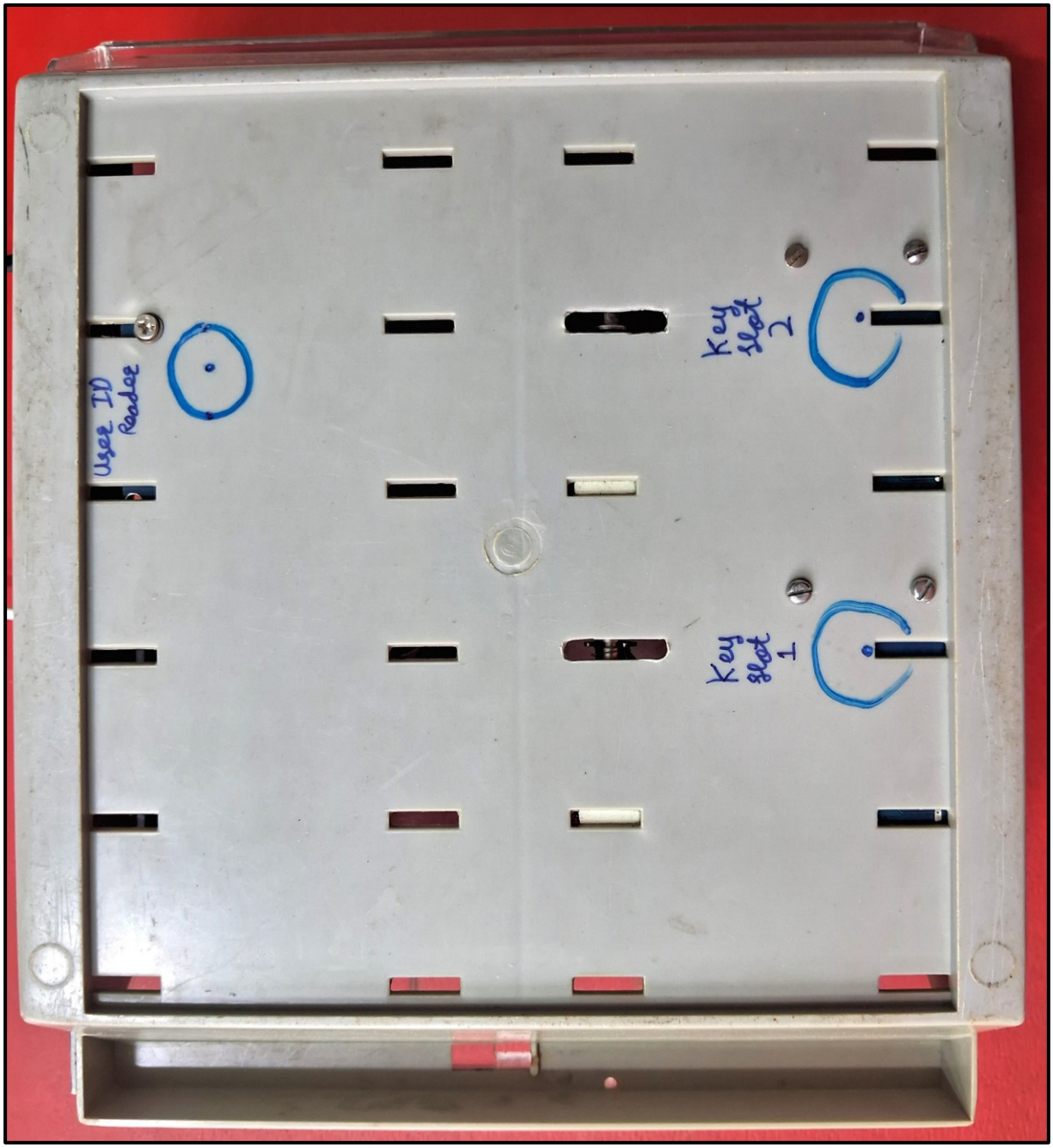
8.2: Current System Implementation

8.2.1: Hardware Implementation

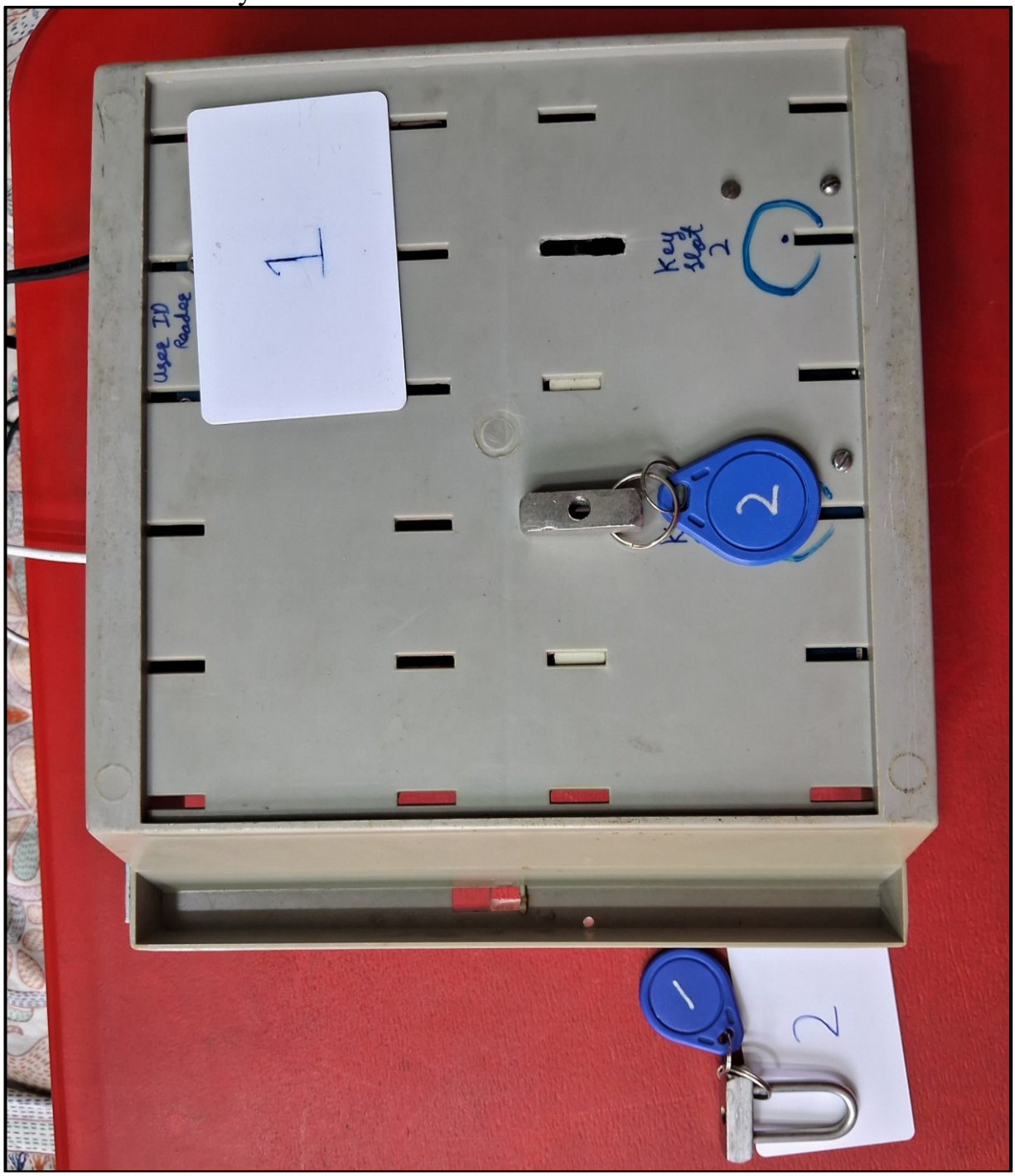
Implemented Circuit Wiring Diagram:



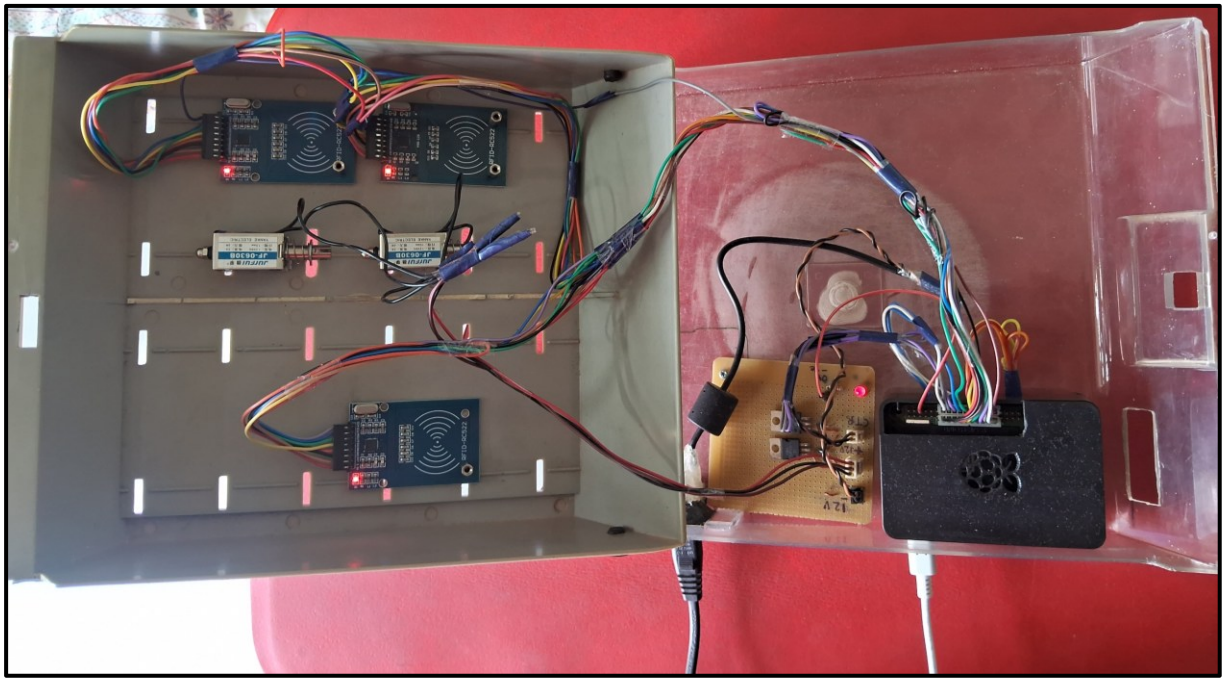
Front view: Visible to end users:



Front view with key inserted and location of user ID card reader shown:



Internal view:

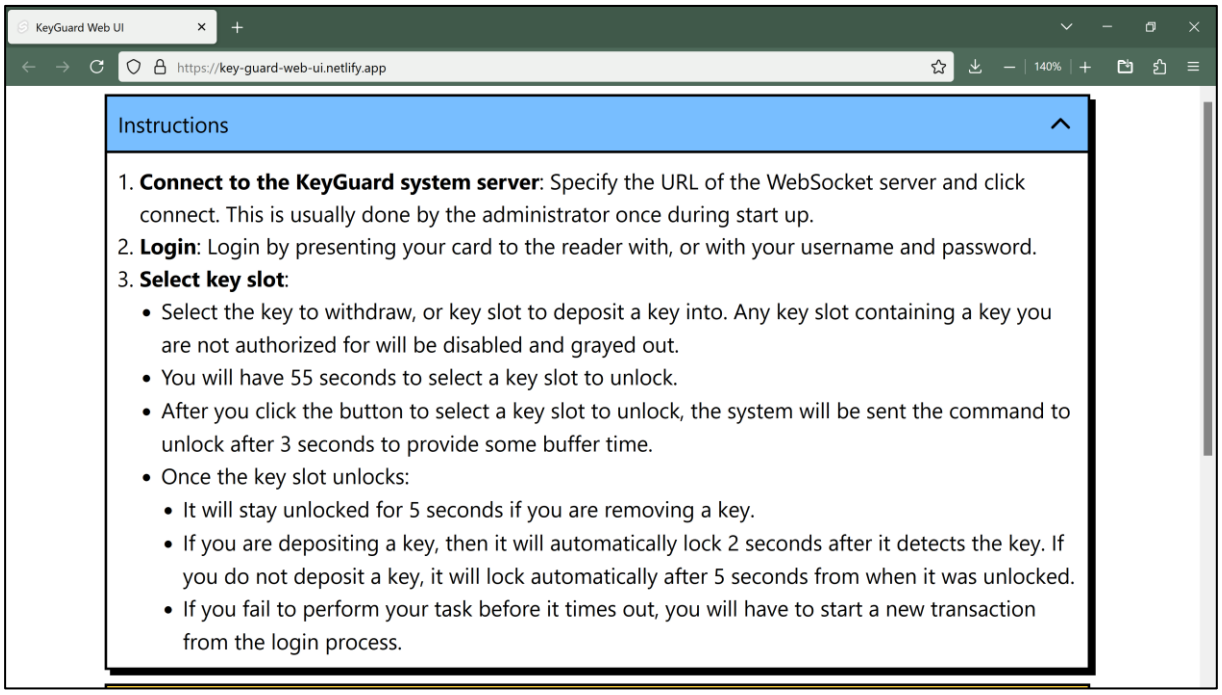


Hardware details:

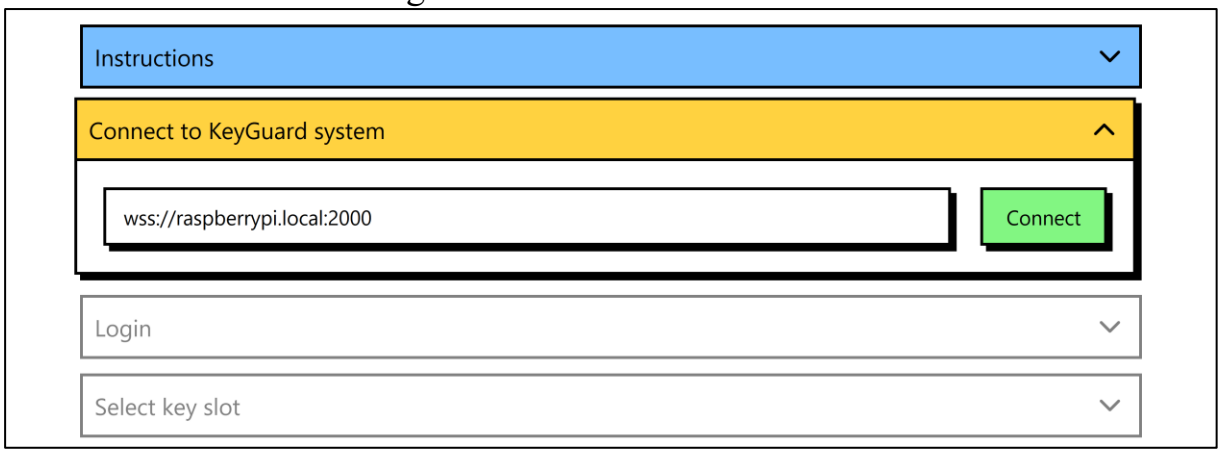
- The currently implemented prototype runs on a Raspberry Pi system.
- It has 2 key slots, each with
  - 1 solenoid to latch the key into the slot.
  - 1 RFID reader to identify the key placed in the slot.
- It also has a RFID reader for the user authentication module.
- The RFID readers are connected to the system via a shared SPI bus.
- The key identification module supports 2 keys:
  - Key 1: Key to Lab Alpha
  - Key 2: Key to Device Beta
- The user authentication module's database currently contains 2 authorized users:
  - User 1: Can access Key to Lab Alpha and Key to Device Beta
  - User 2: Can only access Key to Lab Alpha.
- Any unrecognized keys and user ID cards are rejected.
- The Python WebSocket server is implemented using the websockets PyPi package.

8.2.2: Software-side Web UI

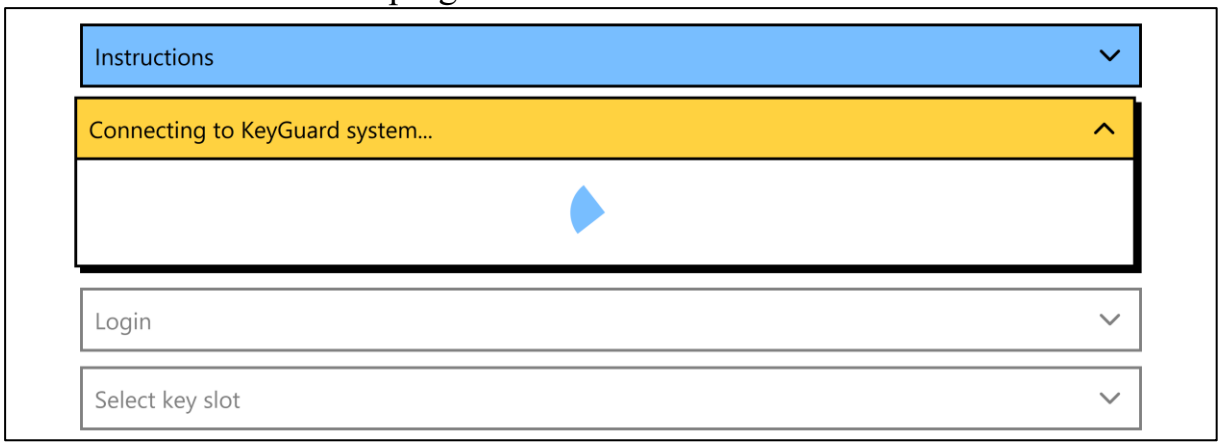
Instructions:



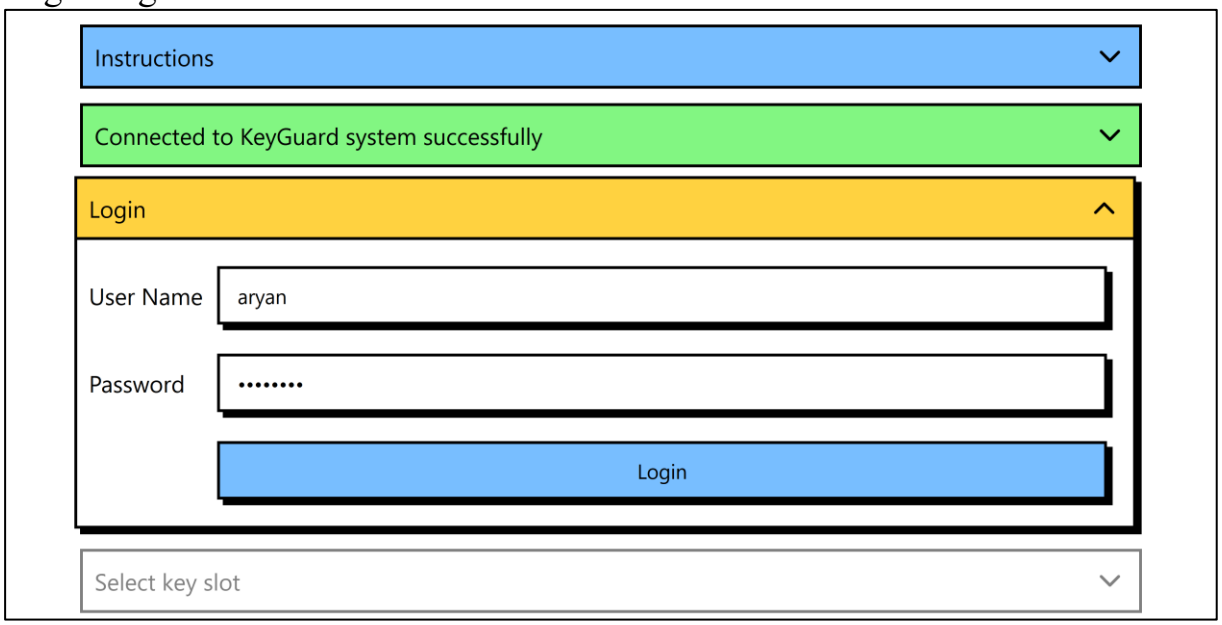
WebSocket Connection stage:



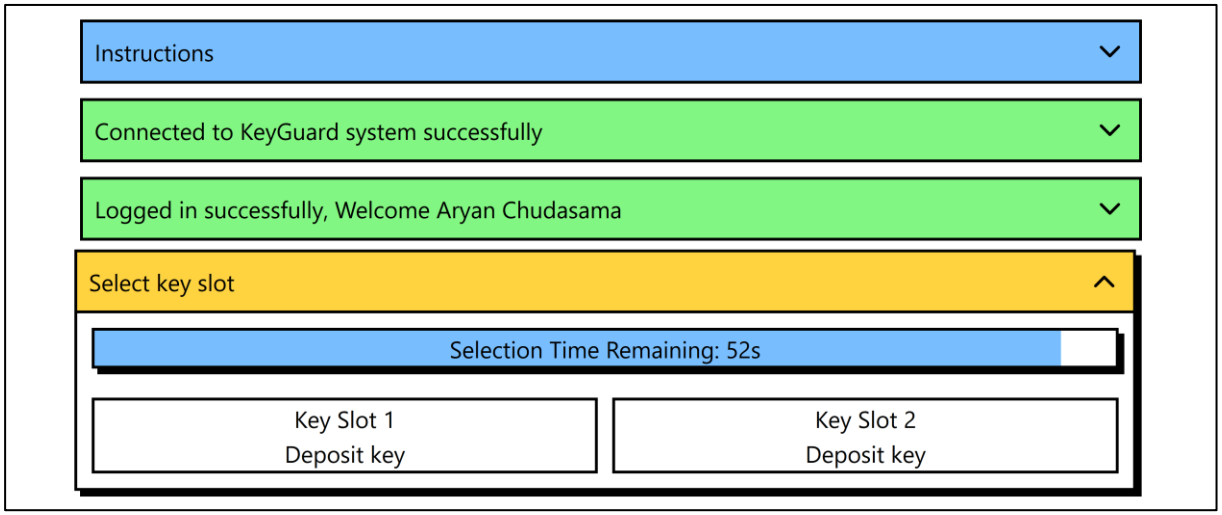
Connection handshake in progress:



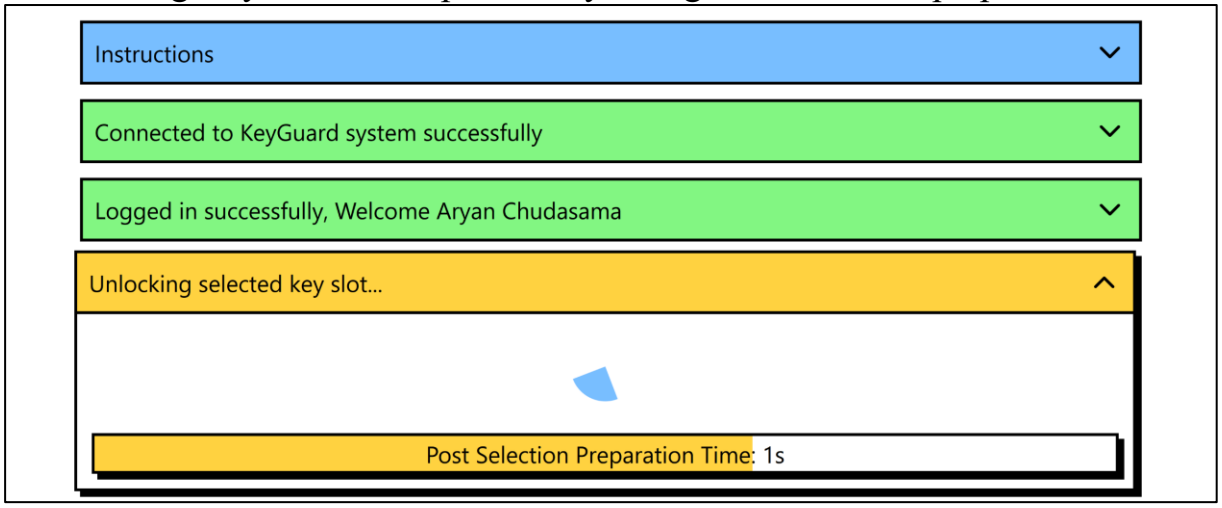
Login Page:



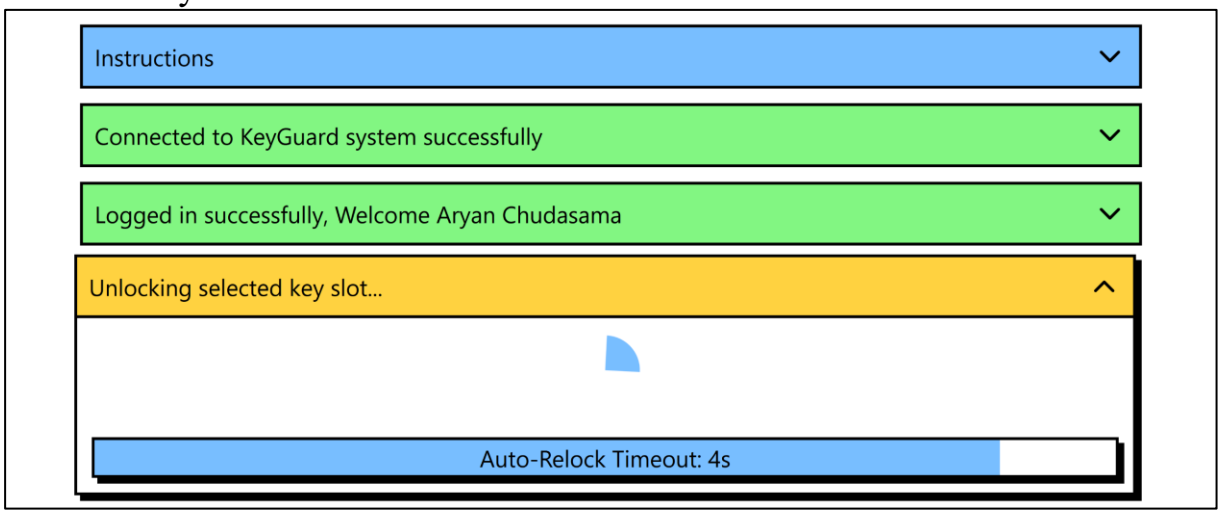
After logging in using the username & password or the user ID card of User 1:



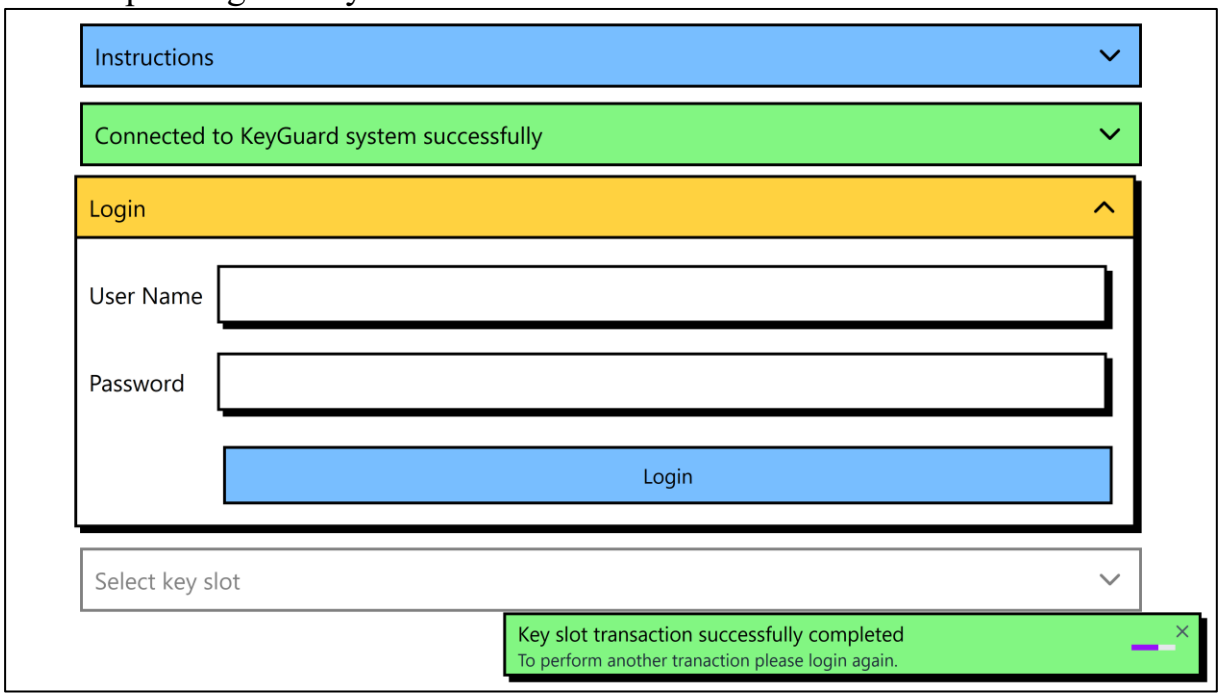
On selecting Key Slot 1 to deposit a key: We get 3 seconds to prepare ourselves.



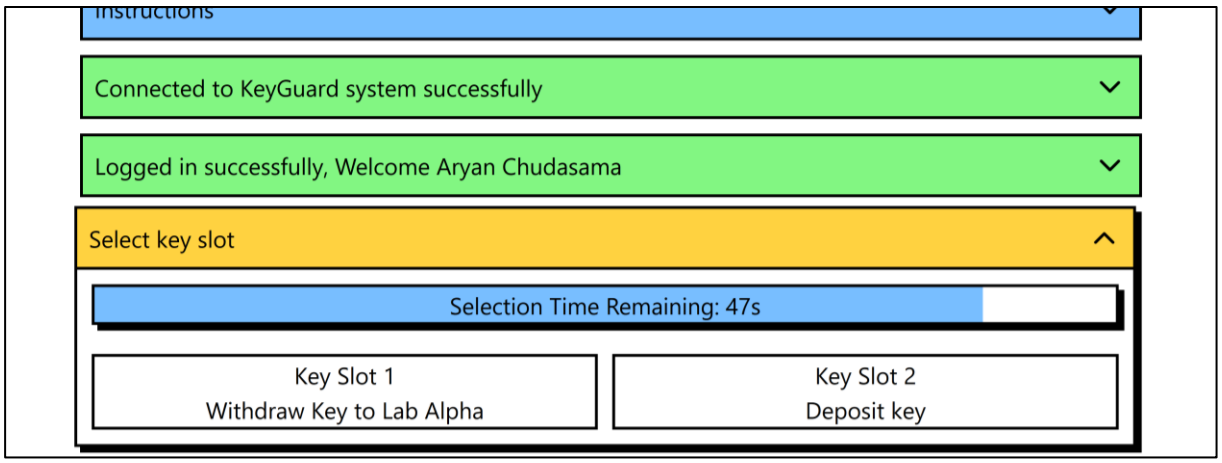
Then the key slot unlocks:



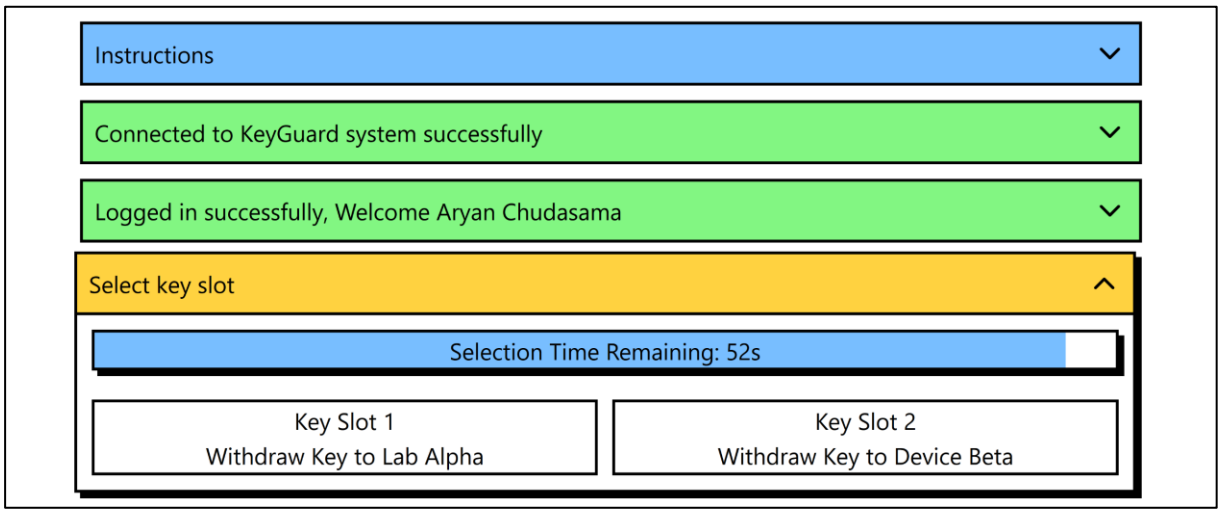
After depositing the key:



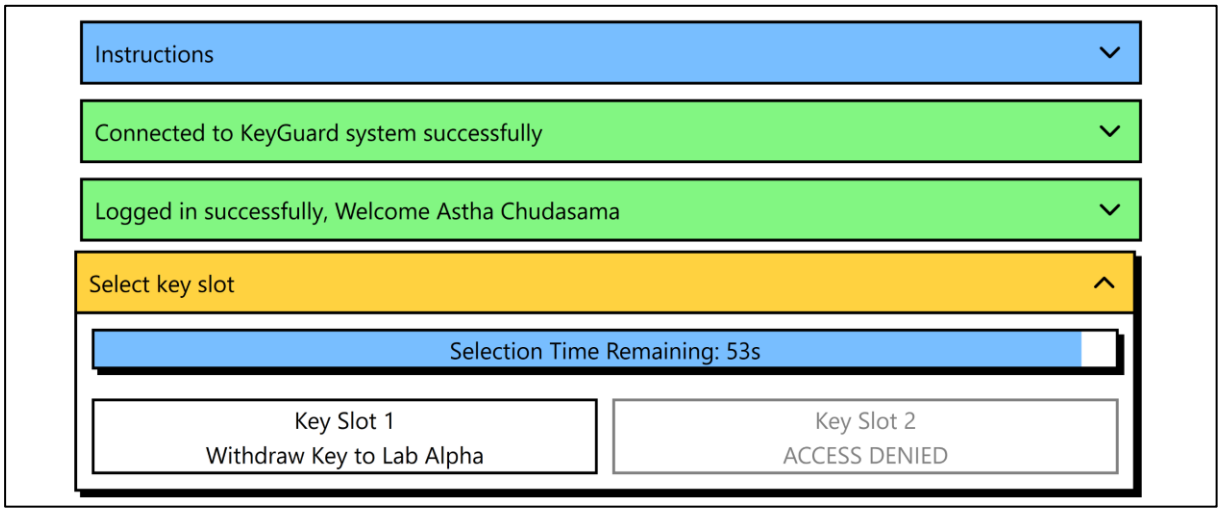
Then, after logging in we can see that we now have the option to withdraw the key, right now we will deposit the other key.



Then after logging in again we see that User 1 has the option to withdraw either key:



However, User 2 is forbidden from accessing the Key to Device Beta:



To withdraw any key simply click on the button and proceed similarly to the key check-in process.

Software details:

- The Web UI is developed using the Svelte.js 5 & SvelteKit framework(s).
- The codebase is in TypeScript to provide static typing during bundling time.
- The component styling is implemented using Tailwind CSS in conjunction with Svelte's scoped CSS styles (on top on PostCSS).
- It uses WebSockets to communicate with the RPi server.
    - The websocket-as-promised library is used as a wrapper over the native JS WebSocket class to provide a support for fluent asynchronous code using Promises and the async/await syntax.

CHAPTER 9: CONCLUSION

The KeyGuard project has showcased the versatility and efficacy of hardware key management systems (KMSes). It is useful across various domains. From schools to factories, the project has demonstrated the potential to revolutionize industries & institutes and enhance efficiency. The successful integration of automatic authentication features and seamless access to assigned keys signifies a promising future for the KeyGuard key management system technology.

Future Scope:

1. GUI based administrator panel for addition of users & keys.
2. Notification system to inform the administrator when a noteworthy event occurs like when a key is stolen.
3. Addition of more key identification modules, and correspondingly more keys.
4. Automatic tracking of the location of the keys via GPS trackers
5. Facial recognition or thumbprint biometric technology for authorization purposes.
6. Extension cabinet support to add a new cabinet to hold more slots for keys.

CHAPTER 10: REFERENCES

https://www.mivanta.com/Assets/KeyGuard-Assets/images/products_page_images/KeyGuard-Manual.pdf
https://robu.in/product/mifare-rfid-readerwriter-13-56mhz-rc522-spi-s50-fudan-card-and-keychain/
https://www.raspberrypi.org/
https://docs.python.org/3.11/
https://github.com/pimylifeup/MFRC522-python
https://pimylifeup.com/raspberry-pi-rfid-rc522/
https://gpiozero.readthedocs.io/en/latest/
https://pypi.org/project/pyjson5/
https://pinout.xyz/pinout/spi
https://pypi.org/project/spidev/
https://svelte.dev/
https://github.com/vitalets/websocket-as-promised
https://tailwindcss.com/docs
https://www.typescriptlang.org/docs/
https://websockets.readthedocs.io/en/stable/