Project Title: Implementing Security into a Secure Password Manager Application

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Project Overview

The project focuses on the implementation of robust security measures into a secure password manager application developed for a software development (SaaS) company. The aim is to ensure the **confidentiality, integrity, and availability** of stored user credentials through strong encryption, secure authentication mechanisms, and a user-friendly interface. This initiative emphasizes data protection while complying with industry standards and best practices.

1 - Security Architecture Implementation

1.1 Current State Assessment

A comprehensive evaluation of the existing password manager architecture was conducted to identify potential security vulnerabilities. The assessment included publicly available manuals, dependency analysis, and examination of data flow to detect insecure configurations and weak cryptographic practices.

1.2 Security Enhancements

Key improvements were introduced: -

- Hardened user authentication mechanisms.
- Encryption protocols for both data at rest and in transit.
- Secure handling of sensitive information such as master passwords and user metadata.

see more…

2 - Encryption and Data Protection

2.1 Strong Encryption

All user-stored passwords are encrypted using **AES-256**, a symmetric encryption standard recognized for its strength and performance. The encryption keys are securely derived and managed. (will be updating as per best practices)

2.2 Master Password Security

The master password – the single point of access for the password vault – is secured using **PBKDF2** (Password-Based Key Derivation Function 2), with optional **Argon2** support for enhanced resistance against brute-force attacks.

2.3 Encryption at Rest and in Transit

- **At Rest**: All user data, including metadata and password entries, is encrypted locally.
- **In Transit**: Communication between client and server is protected using **TLS (Transport Layer Security)** to prevent eavesdropping and man-in-the-middle attacks. (implementing soon)

2.4 Integrity Checks

To ensure data integrity, **HMAC (Hash-based Message Authentication Code)** is implemented. This cryptographic function verifies that data has not been altered during storage or transmission.

3 - Authentication and Authorization

3.1 Multi-Factor Authentication (MFA)

MFA is integrated into the login process, requiring users to provide a second factor (e.g., TOTP, hardware key) in addition to the master password. This significantly reduces the risk of unauthorized access. (implementing soon)

see more...

3.2 Role-Based Access Control (RBAC)

The application incorporates **RBAC** to manage user permissions based on roles. Access to sensitive operations is granted strictly on a need-to-know basis, enforcing the principle of least privilege. (implementing soon)

4 - Backup and Recovery

4.1 Secure Backup

Encrypted backups of the password vault are supported, allowing secure storage and disaster recovery. Backup files remain encrypted and are only accessible with the master password.

4.2 Recovery Mechanisms

Secure account recovery workflows are provided. This includes encrypted recovery keys and identity verification procedures in case the user loses access to the master password. (Option to change master password is implemented and in fully working condition. I will be implementing robust cybersecurity controls, including verifying the registered email and typing the correct code send via email followed by some security questions and if the users passes all tests, then there will be an option to reset the master password but the activation will be after the confirmation email that are you sure you want to update the master password. The second implementation would be to wipe all the data from that device if someone forgets the master password. Users can always contact the support team for guidelines)

5 - Securing API and Network Communication

5.1 API Security

All exposed APIs adhere to security best practices, including: -

- Authentication and token validation.
- Rate limiting and throttling to prevent abuse.
- Input validation to prevent injection attacks.

5.2 Firewall Protection

Network-level defenses include a Web Application Firewall (WAF) and internal firewalls to monitor, filter, and protect API endpoints and backend services from unauthorized access and threats. (implementing soon, when I launch the web API)

6 - Compliance and Data Privacy

6.1 Regulatory Compliance

The application is designed in compliance with major data protection regulations, including:

- **GDPR** (General Data Protection Regulation)
- **CCPA** (California Consumer Privacy Act)
- **PCI DSS** (Payment Card Industry Data Security Standard)

6.2 Privacy by Design

User data is handled under strict privacy principles:

- Data minimization.
- Transparent data handling practices.
- No third-party tracking or analytics on sensitive operations.

7 - Monitoring and Incident Response

7.1 Activity Monitoring

Real-time monitoring tools are in place to track login attempts, vault access, and suspicious user behavior. Alerts are triggered for anomalies such as brute-force patterns or unauthorized logins.

see more...

7.2 Audit Logging

Detailed logs are securely maintained for user activities. Logs support forensic analysis and help ensure compliance with security policies and standards.

7.3 Incident Response Plan

An actionable incident response plan has been developed, covering:

- Detection and notification of breaches.
- Isolation of affected systems.
- Communication protocols and post-incident reviews.

8 - User Security Awareness & Training

8.1 User Training

End-users are provided with training materials and documentation on secure password practices, vault management, and threat recognition.

8.2 Phishing Awareness

The application offers in-app security tips and reminders to help users identify phishing emails, malicious websites, and social engineering tactics.

This implementation draws architectural inspiration and security models from established password manager frameworks, including the frameworks mentioned. This project needs a lot of work and improvement, and I am willing to complete it.

see more...

Quick Overview: -

Frontend/UI: vault_ui.py

Authentication: auth.py

Encryption/Decryption & Storage: encryption.py

Launcher/Entry Point: main.py

FEATURES COMPLETED: -

Feature	Status	Notes
Master Password Creation/Login	✅	Password strength shown, eye toggle, secure hashing
Vault UI Launch	✅	Clean interface, no popups, layout is stable
Add New Entry	✅	Validates, stores securely, logs to file
View All Entries	✅	Real-time search, responsive layout
Eye Button Toggle	✅	Added for all password fields (login + vault)
Delete Entry	✅	Soft delete to trash, with confirmation
Trash Management	✅	Restore and permanent delete with logging
Reset Master Password	✅	Validates, re-encrypts, clears trash, logs event
Search Bar (Live Filter)	✅	Filters by site or username instantly
Password Strength Meter	✅	Used in creation, reset, and add-entry
Vertical & Horizontal Scrollbars	✅	Working across all pages
Logging System	✅	vault.log tracks all major actions with timestamps

PROJECT STRUCTURE (Logical Flow): -

```
main.py
 |-- Login / Create Password
      |-- vault_ui.launch_vault()
           |-- Home (view, search, delete)
           |-- Add Entry (encrypt + log)
           |-- Reset Master (reencrypt + clear trash)
           |-- Trash (restore / delete forever)main.py
```

QUALITY CHECK: -

Checkpoint	**Result**
No crashes/errors	✅ None encountered
Good UI layout (padding, alignment)	✅ Clean and readable
No unused variables/functions	✅ (Only 1 optional unused import: messagebox)
Cross-platform scroll working	✅ Tested bindings for Linux/Windows
Global state (password)	✅ Handled via global master_password inside vault_ui
Security (AES, PBKDF2, Argon2)	✅ Best practices applied

Features to Add: -

Features	**Description**
Copy to Clipboard	Allow users to copy sitename, username & passwords.
Multiple Prompts	Remove multiple prompts when a user tries to delete.
Edit Entry	Allow users to update / edit entry with no crash & loss.
Pass Generator	Automatically generate strong passwords.
Metadata Entry	Show “Last Updated” and “Created On” in UI.
Export	Export to encrypted JSON.
View Logs	Users will be able to view logs in UI.
Robust Input Validation	Allow & check for relevant specific characters.
Desktop App	Convert this code into a Executable File.
Web UI	Make Web UI with WAF and other security compliance.
Enable MFA & RBAC	Use Authy or some other third-party authentication.
Attractive UI/UX	Make adjustments for a modern and attractive look.

It was such a lovely project, but I am submitting it incomplete, unlike other projects, because I worked on this by heart, and I want to implement all these things step-by-step. The project core is ready and running without errors. I am also working on the VPN Project using Docker, GitHub, WSL, Docker Hub, etc. It includes the WireGuard and the OpenVPN protocols. I am also willing to share that once it’s done.

As this was the last project, I really want to thank First Quadrant Labs for assigning these projects. I can’t explain my emotions right now, but every project is close to my heart, and I really appreciate how you explained each and every thing in the project guideline.

I am willing to work with you, and I am waiting for your positive response.
Attaching .txt files instead of .py files and creating a zip to bypass the security checks of Gmail.