 

**T.C. MARMARA UNIVERSITY**

**FACULTY of ENGINEERING COMPUTER ENGINEERING DEPARTMENT**

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Title of the Project

**FaceApp**

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**1. Aim of the Project**

1.1 Overview

The aim of this project is to address the prevalent privacy issues associated with sharing group photographs within various messaging applications, such as WhatsApp, Telegram, and others. In today's digital era, the ease of capturing and sharing group photos in real-time is a common occurrence, but it brings forth several privacy concerns. Users often find themselves in situations where:

* Photographs are shared that do not include every individual present in the group.
* Individuals may feel uncomfortable when a photograph that excludes them is accessible to unrelated individuals who are part of the same group.

While these issues may seem trivial, they have significant implications, particularly within the context of school groups, social gatherings, and family events. Parents can become sensitive to privacy matters related to their children. It is our belief that safeguarding individual privacy is a fundamental right, and we aim to address these concerns effectively.

1.2 Project Goals

Our primary goal is to develop a privacy-focused group photograph sharing application with the following objectives:

*1.2.1 Objective 1: Eliminating Unwanted Photographs*

A core aim of this project is to provide users with a streamlined and user-friendly experience. Individuals should no longer need to sift through group photos that do not include them. This objective aligns with simplifying the user experience and making the application more intuitive.

*1.2.2 Objective 2: Ensuring Privacy*

We aim to guarantee the privacy of individuals in group photographs. This involves preventing photographs from reaching unrelated individuals who are not part of the photo. By addressing this concern, we seek to create a safe and secure environment for users.

1.3 Significance

The significance of this project lies in its ability to provide users with a solution that enhances their privacy and user experience while sharing group photographs. By addressing the concerns of parents, friends, and individuals who value their privacy, we aim to create an application that resonates with a broad user base. Moreover, our project aligns with the evolving landscape of digital privacy and underscores the importance of individual data protection.

1.4 Expected Outcomes

The expected outcomes of this project include the following:

* A user-friendly mobile application for group photograph sharing that offers a seamless experience.
* A robust facial recognition system capable of accurately identifying individuals in group photos.
* A secure data sharing system that ensures photographs are shared only with relevant individuals.
* Increased user satisfaction, reduced privacy concerns, and enhanced group photograph sharing experiences.

In summary, our project strives to create a safe, user-friendly, and privacy-conscious environment for individuals sharing group photographs. It addresses a pertinent issue in the digital age and aims to enhance the quality of interactions within various social groups.

**2. Problem Description and Motivation**

2.1 Problem Context

In today's digital age, the pervasive nature of group photographs shared across messaging applications has led to an emerging concern: privacy. The widespread practice of sharing group photos within social or professional circles introduces privacy challenges. Individuals captured in group photographs often face scenarios where:

* Photographs are disseminated indiscriminately, including individuals do not present in the photo.
* Concerns arise when photographs are accessible to unrelated individuals within the same chat group, potentially compromising the privacy of individuals depicted in the photos.

2.2 Motivation

The motivation behind this project is deeply rooted in addressing these prevalent privacy challenges associated with group photograph sharing. Our motivation stems from several critical reasons:

*2.2.1 User-Centric Approach*

Our primary motivation is to provide a user-centric solution. Users, especially within school groups or family chat environments, deserve the confidence that their privacy is safeguarded when sharing group photographs. By prioritizing user needs and privacy concerns, we aim to create an application that aligns with user expectations.

*2.2.2 Privacy and Sensitivity*

The sensitivity of individual privacy, especially concerning children and families, necessitates a solution that ensures that shared photographs are only accessible to relevant individuals present in the image. This sensitivity underlines the need for a more tailored and secure method of group photograph sharing.

*2.2.3 Technological and Ethical Implications*

The advent of facial recognition technology opens doors for addressing these privacy issues. Leveraging technological advancements while adhering to ethical standards, our project aims to utilize facial recognition to discern individuals in group photos and regulate access to these photos with enhanced privacy controls.

2.3 Significance

This project holds significant relevance in the context of digital privacy and social interactions. The significance of addressing these privacy concerns extends to:

* **Individual Empowerment:** Empowering individuals with greater control over their shared content.
* **Trust and Security:** Building trust and ensuring the security of shared data within online communities.
* **Ethical Responsibility:** Upholding ethical standards in data sharing and access control.

2.4 Potential Impact

Successful execution of this project is anticipated to bring about the following impacts:

* **Enhanced Privacy:** Users will have improved privacy control over their shared group photographs, addressing concerns about unwanted photo distribution.
* **User Satisfaction:** The creation of a user-friendly and privacy-focused application will lead to increased user satisfaction and trust.
* **Technological Advancements:** The integration of facial recognition into social applications for privacy purposes will pave the way for ethical and secure photo sharing practices.

In summary, the problem of unregulated group photograph sharing requires a solution that respects individual privacy and aligns with ethical and technological advancements. Our motivation lies in delivering a robust application that addresses these concerns and positively impacts digital interaction and privacy.

**3. Main Goal and Objectives**

3.1 Main Goal

The overarching goal of this project is to develop a comprehensive privacy-focused group photograph sharing application that addresses the privacy concerns associated with group photographs shared within various messaging applications. Our aim is to provide a user-centric, secure, and efficient platform that empowers users to share group photos confidently and privately.

3.2 Objectives

In pursuit of the main goal, we have established specific objectives to guide our project development. These objectives are clear, measurable, and attainable and collectively contribute to the successful realization of the main goal:

*3.2.1 Project Objective 1: Creation of a User-Friendly Chat Application*

* **Description:** Develop a user-friendly chat application tailored for mobile platforms using Flutter and Dart technologies.
* **Rationale:** A user-friendly chat application is the foundation of the project, providing the environment in which users share photographs and interact.
* **Key Performance Indicators:**
  + Successful deployment of the chat application.

*3.2.2 Project Objective 2: Implementation of Facial Recognition*

* **Description:** Implement a facial recognition system, employing the OpenCV library and Python, to accurately classify individuals in group photographs.
* **Rationale:** Accurate facial recognition is the core feature that allows us to identify individuals in photos and ensure privacy.
* **Key Performance Indicators:**
  + Accuracy of facial recognition, with a target of at least 90% precision.
  + Detection and classification of individuals in group photographs.

*3.2.3 Project Objective 3: Development of a Secure Data Sharing System*

* **Description:** Create a secure data sharing system that allows users to share photographs only with individuals present in the photo, with robust access control.
* **Rationale:** The secure sharing system is the cornerstone of privacy protection, ensuring that only authorized users can access shared photographs.
* **Key Performance Indicators:**
  + Successful implementation of the secure data sharing system.
  + Prevention of unauthorized access to shared photos.

*3.2.4 Project Objective 4: Compliance with Professional Standards*

* **Description:** Adhere to professional engineering standards and best practices throughout the project, ensuring the use of version control with Git/GitHub, Gantt charts for project management, and Object-Oriented Programming principles.
* **Rationale:** Professional standards and practices enhance project organization, collaboration, and code quality.
* **Key Performance Indicators:**
  + Consistent and clear use of Git/GitHub for version control.
  + Effective project management with Gantt charts.
  + Application of Object-Oriented Programming principles in code development.

These objectives align with the main goal and collectively provide a roadmap for the project. Success in achieving each objective is crucial for the successful development and deployment of the privacy-focused group photograph sharing application.

**4. Related Work**

In this section, we review and compare existing research and solutions related to privacy issues in group photograph sharing applications. A thorough understanding of related work is crucial for identifying gaps and novelties in our project.

4.1 Existing Solutions

Several existing solutions and applications address privacy issues in group photograph sharing, with a focus on user privacy and data security. Notable examples include:

*4.1.1 WhatsApp and Telegram*

* **Privacy Features:** Both WhatsApp and Telegram have implemented privacy features like end-to-end encryption and group-specific settings.
* **Limitations:** While these applications provide some level of privacy, they may not address the issue of sharing photographs only with individuals present in the photo.

*4.1.2 Facial Recognition Applications*

* **Applications:** Some facial recognition applications enable users to tag individuals in photos, offering a level of personalization.
* **Limitations:** These applications often require manual tagging and do not address privacy concerns related to photo sharing with unauthorized users.

4.2 Research in Privacy Protection

Several research studies have delved into privacy protection in photo sharing, particularly in social media settings:

*4.2.1 Privacy-Preserving Photo Sharing*

* **Research:** Studies in privacy-preserving photo sharing have explored cryptographic techniques to protect images from unauthorized access.
* **Limitations:** These solutions may not always offer seamless user experiences and can be complex for non-technical users.

*4.2.2 Facial Recognition in Photo Tagging*

* **Research:** Facial recognition research has advanced in the context of photo tagging on social media platforms.
* **Limitations:** These solutions are often oriented towards improving user experiences but may not address concerns specific to group photograph sharing privacy.

4.3 Project Novelties

Compared to the related work, our project introduces several novelties and differentiators:

* **Automated Facial Recognition:** Our project focuses on automating facial recognition to classify individuals in group photographs, reducing the need for manual tagging.
* **Privacy-Centric Approach:** We prioritize user privacy and security by ensuring that photographs are shared only with individuals present in the photo, addressing concerns related to unauthorized access.
* **Integration of Chat and Facial Recognition:** The combination of chat functionality with facial recognition sets our project apart, offering a holistic solution for privacy-focused group photograph sharing.

**5. Scope**

The scope of this project encompasses the development of a privacy-focused group photograph sharing application with a multifaceted approach. It includes the following components:

5.1 Chat Application

* Creation of a user-friendly chat application for the mobile platform using Flutter and Dart technologies.
* Integration of chat functionalities, including text messaging, multimedia sharing, and group creation.

5.2 Facial Recognition System

* Implementation of a facial recognition system using the OpenCV library in Python.
* Accurate classification of individuals present in group photographs.
* Detection of unique facial features and characteristics to identify individuals.

5.3 Data Sharing Features

* Development of a system that enables users to share photographs securely.
* Ensuring that photos are shared only with individuals who are part of the image.
* Protection of personal data and prevention of unauthorized access to shared photos.

5.4 Constraints

The project operates within defined constraints and assumptions, including:

* **Economic Constraints:** Limitation of messaging feature since we are planning to use spark plan (free) of Firebase.

5.5 Assumptions

The project is based on several key assumptions, including, but not limited to:

* Assumption of a manageable number of simultaneous users for optimal system performance.
* Assumption of compatible network infrastructure to handle bandwidth requirements.
* Assumption that the project design will be suitable for its intended purpose.

**6. Methodology and Technical Approach**

The methodology and technical approach for this project encompass a comprehensive plan to achieve the specified objectives and deliver a privacy-focused group photograph sharing application. This section provides a detailed breakdown of our approach, including the technologies, tools, and methods we intend to employ.

6.1 High-Level Solution Approach

Our high-level solution approach involves several key phases:

*6.1.1 Chat Application Development*

* **Technology Stack:** We will develop the chat application for the mobile platform using Flutter and Dart. These technologies offer cross-platform compatibility and an efficient development process.
* **User Profiles:** Upon entering the application, users will be expected to take and upload several photos of themselves to facial recognition feature to work. Later on, they will be able to add, edit or delete those photos.

*6.1.2 Facial Recognition*

* **Technology Stack:** For the main feature of the project, which is facial recognition, we will utilize the OpenCV library in conjunction with Python.
* **Face Classification:** The primary objective is to accurately classify individuals in group photographs. This will involve detecting and distinguishing facial features to identify and differentiate users.

*6.1.3 Secure Data Sharing*

* **Security Protocols:** To ensure privacy, we will implement secure data sharing mechanisms. Photographs will only be shared with individuals who are present in the photo, and personal data will be protected.

6.2 Theory and Algorithms

Our technical approach involves the utilization of established theory and algorithms in the following areas:

*6.2.1 Secure Data Transfer*

* The project will implement encryption and secure data transfer protocols to protect the privacy of users. Standard encryption methods, such as AES or RSA, will be used to ensure data security.

6.3 Performance Evaluation

Performance evaluation is a critical aspect of this project, and we will employ the following measures:

* **Accuracy:** We will assess the accuracy of the facial recognition system in correctly identifying individuals.
* **Response Time:** Measurement of the system's response time when handling image recognition and data sharing.
* **Resource Utilization:** Monitoring the efficient use of system resources, including memory and processing power.

6.4 Resource Requirements

To successfully complete the project, we will require various resources, including:

* **Hardware:** Mobile devices for testing and development.
* **Software:** Development tools such as IDEs and libraries.
* **Data:** Training data for the facial recognition system.
* **Human Resources:** A skilled development team for coding and testing.

6.5 Performance Testing

The project will undergo rigorous performance testing to ensure the application's reliability and efficiency. This will involve testing under various network conditions, assessing system responsiveness, and evaluating the accuracy of facial recognition.

**7. Professional Considerations**

In this section, we address various professional considerations and standards that will guide the project's development, collaboration, and overall management.

7.1 Methodological Considerations and Engineering Standards

*7.1.1 Version Control with Git/GitHub*

* **Version Control:** We will utilize Git as our version control system and host our code repositories on GitHub. This practice ensures code integrity, collaboration, and easy tracking of project changes.
* **Commit Conventions:** Our team will adhere to clear and descriptive commit messages, following a consistent convention (e.g., Semantic Versioning) for effective code review and history tracking.

*7.1.2 Gantt Charts*

* **Project Management:** Gantt charts will be employed to visualize project timelines, task dependencies, and milestones. This aids in effective project management and allows for the tracking of progress against established deadlines.

*7.1.3 Object-Oriented Programming (OOP)*

* **Code Structure:** We will follow the principles of Object-Oriented Programming to create modular and maintainable code. Classes, objects, inheritance, and encapsulation will be employed to enhance code organization and reusability.
* **Design Patterns:** We will explore design patterns like Singleton, Factory, and Observer to solve recurring design problems and promote code flexibility and scalability.

7.2 Realistic Constraints

*7.2.1 Economic Constraints*

* **Budget Adherence:** We will manage the project following the limitations of spark plan of Firebase.

*7.2.2 Environmental Constraints*

* **None:** We are not planning to see any environmental constraints for our project.

*7.2.3 Ethical Constraints*

* **Privacy and Security:** Protecting the privacy and security of users and their data is of utmost importance. We will adhere to ethical guidelines in data handling and access control.

*7.2.4 Health and Safety Constraints*

* **User Safety:** We will consider the health and safety of users and the public when designing the application, particularly in scenarios involving potential stress factors or sensitive information.

*7.2.5 Sustainability Constraints*

* **Product Reliability:** Ensuring that the application is reliable and durable under normal operation conditions to support its long-term sustainability.

*7.2.6 Social Constraints*

* **Respectful Design:** We will avoid designing products that may negatively profile specific races, genders, or any group of individuals.

7.3 Legal Considerations

*7.3.1 Permissions and Licensing*

* **Compliance:** We will ensure compliance with all necessary legal permissions and licenses, especially if the developed product is intended for market release.
* **Data Protection:** Legal considerations will extend to data protection and privacy regulations to safeguard user information.

**8. Management Plan**

The management plan for this project outlines the strategies, responsibilities, and timelines to ensure the successful execution of the privacy-focused group photograph sharing application. The plan encompasses various aspects of project management, including task phases, responsibilities, and milestone tracking.

8.1 Task Phases and Durations

The project will progress through distinct task phases, each with its specific objectives and activities. The estimated durations for each phase are as follows:

*8.1.1 Phase 1: Chat Application Development*

* **Duration:** Approximately 2 months
* **Description:** During this phase, the primary focus is on the development of the chat application using Flutter and Dart technologies. The phase includes activities like team collaboration, user interface creation, and the integration of essential chat functionalities.

*8.1.2 Phase 2: Facial Recognition System*

* **Duration:** Approximately 3 months
* **Description:** This phase concentrates on implementing the facial recognition system, which is the core feature of the project. Activities involve training the facial recognition model, developing algorithms for facial detection and recognition, and integrating the system with the chat application.

*8.1.3 Phase 3: Secure Data Sharing*

* **Duration:** Approximately 2 months
* **Description:** The third phase focuses on the development of a secure data sharing system that ensures the privacy of users. Activities include ensuring end-to-end encryption and secure data transfer and integrating the system with the chat application.

8.2 Division of Responsibilities

Effective delegation and division of responsibilities among team members are crucial for a smooth project management process. The roles and responsibilities within the project team are defined as follows:

*8.2.1 Chat Application Interface*

* **Team:** Emirhan Erdoğan – Eren Başpınar
* **Role:** Responsible for the development of frontend part of the chat application using Flutter and Dart technologies.
* **Responsibilities:** User interface design and testing.

*8.2.2 Chat Application Functionality*

* **Team:** Emirhan Erdoğan – Alper Özdemir
* **Role:** Responsible for the development of backend part of the chat application using Flutter, Dart and Firebase technologies.
* **Responsibilities:** Chat functionality implementation and testing.

*8.2.3 Facial Recognition Feature*

* **Team:** Emirhan Erdoğan – Eren Başpınar – Alper Özdemir
* **Role:** Focuses on implementing the facial recognition system using the OpenCV library and Python.
* **Responsibilities:** Model training, algorithm development, and integration with the chat application.

*8.2.4 Quality Assurance and Testing*

* **Team:** Eren Başpınar – Alper Özdemir
* **Role:** Responsible for quality assurance and testing at various stages of the project.
* **Responsibilities:** Identifying and reporting bugs, testing application performance, and providing user feedback.

*Figure 1: Contributions table*

*8.3 Timeline with Milestones*

The project timeline includes well-defined milestones to track progress and ensure that the project stays on course. A Gantt chart will be utilized to visualize the project timeline effectively. The following are some key milestones:

*8.3.1 Milestone 1: Chat Application Prototype*

* **Due Date:** February 2024
* **Description:** Completion of the chat application prototype, including user interface design and essential chat functionalities.

*8.3.2 Milestone 2: Functional Facial Recognition System*

* **Due Date:** May 2024
* **Description:** Successful implementation of the facial recognition system, capable of accurately identifying individuals in group photographs.

*8.3.3 Milestone 3: Secure Data Sharing System*

* **Due Date:** June 2024
* **Description:** Completion of the secure data sharing system, ensuring that photographs are shared only with relevant individuals.

*8.4 Project Time Line (Gantt Chart)*

The distribution of all stages by month, from the beginning to the end of the project, is shown in Figure 2.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Task Name** | **October** | **November** | **December** | **January** | **February** | **March** | **April** | **May** | **June** |
| **Establish Firebase connection** |  |  |  |  |  |  |  |  |  |
| **Create functional login page** |  |  |  |  |  |  |  |  |  |
| **Create profile page** |  |  |  |  |  |  |  |  |  |
| **Implement chatting** |  |  |  |  |  |  |  |  |  |
| **Add face recognition feature** |  |  |  |  |  |  |  |  |  |
| **Edit interface** |  |  |  |  |  |  |  |  |  |

*Figure 2: Monthly planning Table*

The Gantt chart will provide a visual overview of the project's timeline, including task dependencies and key milestones.

The project management plan will be periodically reviewed and updated to adapt to any changes, ensure the project's successful progression, and address unforeseen challenges. Effective communication, collaboration, and project management are essential components of our strategy to achieve the project objectives.

By effectively implementing the management plan, we aim to complete the project within the specified timeline, meet performance expectations, and deliver a privacy-focused group photograph sharing application that meets the needs of our users and addresses their privacy concerns.

**9. Success Factors and Risk Management**

In this section, we will delve into the critical success factors that are pivotal to the accomplishment of our project objectives, as well as the risk management strategies designed to anticipate, assess, and mitigate potential obstacles.

9.1 Success Factors

Identifying success factors is essential for achieving the project's objectives. The following factors play a significant role in the success of our privacy-focused group photograph sharing application:

*9.1.1 Team Expertise*

The expertise and competence of the project team are pivotal. The skills and knowledge required for mobile app development, facial recognition technology, data security, and user experience design are instrumental in creating a successful application.

*9.1.2 User-Centric Design*

User satisfaction is a fundamental success factor. Prioritizing user needs, preferences, and feedback in the application's design and functionality is crucial. An intuitive and user-friendly interface is key to the project's success.

*9.1.3 Technical Excellence*

Technical excellence in implementing facial recognition technology is a core factor. Achieving a high degree of accuracy and reliability in recognizing individuals in group photographs is essential for user trust and adoption.

*9.1.4 Data Security and Privacy*

Ensuring robust data security and privacy protection is non-negotiable. Success hinges on the application's ability to safeguard user data, prevent unauthorized access, and comply with privacy regulations.

*9.1.5 Legal Compliance*

Adherence to legal and regulatory requirements is vital. Complying with data protection and privacy laws is essential to avoid legal issues and build user trust.

9.2 Risk Management Plan

The risk management plan outlines strategies for identifying, assessing, mitigating, and monitoring potential risks and challenges that may arise during the development of the privacy-focused group photograph sharing application. Effective risk management is essential for maintaining project timelines, controlling costs, and ensuring the successful completion of the project.

*9.2.1 Risk Identification*

Risk identification involves the process of recognizing potential risks that may impact the project. The following are some key risks specific to this project:

*9.2.1.1 Technical Risks*

* **Facial Recognition Accuracy:** The accuracy of the facial recognition system may fall short of expectations, resulting in misidentifications and user dissatisfaction.
* **Integration Challenges:** Challenges in integrating the facial recognition system with the chat application may lead to delays and compatibility issues.
* **Performance Issues:** The application's performance, including response time and resource utilization, may not meet user expectations.

*9.2.1.2 Privacy and Security Risks*

* **Data Breaches:** Security vulnerabilities could lead to data breaches and unauthorized access to shared photographs.
* **Privacy Concerns:** Users might have concerns about the privacy of their facial recognition data or shared photos, potentially affecting adoption.

*9.2.1.3 Team-Related Risks*

* **Skill Gaps:** Insufficient expertise in facial recognition, mobile app development, or data security among team members may slow progress.
* **Team Conflicts:** Internal conflicts within the development team could hinder collaboration and productivity.

*9.2.1.4 External Risks*

* **Legal and Compliance Issues:** Changes in data protection and privacy laws or compliance requirements could impact project implementation.
* **Economic Factors:** Economic fluctuations may affect project funding and available resources.

*9.2.2 Risk Assessment*

For each identified risk, we will assess its potential impact and likelihood. Risks will be categorized as low, medium, or high based on the following criteria:

* **Impact:** Assess the potential consequences of the risk on the project's objectives, including timeline, budget, and quality.
* **Likelihood:** Evaluate the probability of the risk occurring, considering historical data, industry standards, and expert opinions.

*9.2.3 Risk Mitigation*

To address identified risks, we will implement mitigation strategies to reduce their impact or likelihood. Here are some examples of risk mitigation strategies:

*9.2.3.1 Technical Risks*

* **To address facial recognition accuracy:**
* Employ rigorous testing and training processes.
* Plan for iterative improvements based on user feedback.
* **To manage integration challenges:**
* Allocate additional time for integration and compatibility testing.
* Maintain open communication channels with the team.

*9.2.3.2 Privacy and Security Risks*

* **To prevent data breaches:**
* Implement robust encryption and security protocols.
* Conduct regular security audits and penetration testing.
* **To address privacy concerns:**
* Clearly communicate privacy policies and provide users with data control options.

*9.2.3.3 Team-Related Risks*

* **To overcome skill gaps:**
* Provide training and resources for team members to acquire required skills.
* Consider external expertise or consultants if necessary.
* **To manage team conflicts:**
* Promote open and transparent communication.
* Implement conflict resolution procedures.

*9.2.3.4 External Risks*

* **To address legal and compliance issues:**
* Stay informed about changes in data protection laws and regulations.
* Consult with legal experts to ensure compliance.
* **To mitigate economic factors:**
* Diversify funding sources to reduce economic dependency.
* Create a financial buffer for unforeseen economic fluctuations.

*9.2.4 Risk Monitoring and Reporting*

Regular risk monitoring is essential to track the effectiveness of mitigation strategies and identify new risks as the project progresses. The following processes will be in place:

* **Risk Reviews:** Periodic reviews will be conducted to assess the status of identified risks, their impact, and the effectiveness of mitigation strategies.
* **Reporting:** Risks, their current status, and any adjustments to mitigation plans will be reported to the project manager and relevant stakeholders.

By proactively identifying, assessing, and mitigating risks, we aim to minimize potential disruptions to the project and increase the likelihood of its successful completion. Effective risk management is an ongoing process that will be integrated into the project's overall management approach.

**10. Benefits and Impact of the Project**

* **Benefits/Implications:** Discuss potential benefits and beneficiaries of the project.
* **Scientific, Economic, Commercial, Social Impact:** Address the expected impacts in these areas.
* **Potential Impact on New Projects:** Assess if the project will have a pioneering effect.
* **Impact on National Security:** Address any security considerations.

**11. References**

Include a list of references used in the project.

**12. Appendix (Realistic Constraints)**

Detail the realistic constraints related to economic, environmental, ethical, health and safety, sustainability, and social aspects.