1. INTRODUCTION

1.1. Project Overview

TransLingua is an AI-powered language translation web application designed to provide accurate and context-aware translations based on user input. The application allows users to enter text, select the source and target languages, and instantly receive translated output. By leveraging a pre-trained generative AI model, the system delivers natural, grammatically correct, and contextually meaningful translations within seconds.

The project aims to simplify multilingual communication for students, professionals, researchers, travelers, and content creators. Instead of relying on basic rule-based translators that often produce literal or inaccurate results, users can depend on TransLingua to generate high-quality translations quickly and efficiently. The application is built using Streamlit for the user interface and integrates the Google Gemini 2.5 Flash model (models/gemini-2.5-flash-latest) for fast and reliable AI-driven translation.

Overall, TransLingua demonstrates the practical implementation of generative AI in multilingual communication by providing a user-friendly, secure, and time-saving solution for real-time language translation.

1.2. Objectives

The main objectives of the TransLingua: AI-Powered Language Translator project are:

- To develop a web-based application that performs multilingual translation using artificial intelligence.
- To allow users to translate text between multiple languages by selecting source and target languages.
- To reduce the time and effort required for manual translation and cross-language communication.
- To integrate a pre-trained generative AI model (Google Gemini 2.5 Flash) for fast, accurate, and context-aware translation.
- To provide a simple, intuitive, and user-friendly interface using Streamlit.
- To enhance user experience by delivering natural, grammatically correct, and meaningful translations in real time.

2. Ideation Phase

2.1. Problem Statement

In today's global digital ecosystem, individuals frequently need to communicate across language barriers, whether for education, business, research, or social interaction. However, many existing translation tools lack contextual understanding, often generating literal translations that may be inaccurate or awkward. Additionally, some platforms have complex interfaces that reduce usability and make the translation process less efficient. Therefore, users require a fast, accurate, and AI-powered translation solution that supports multiple global languages, understands contextual meaning rather than word-by-word translation, provides an intuitive and accessible user interface, and ensures secure handling of user input.

Problem Statement (PS)	I am	I'm trying to	But	Because	Which makes me feel
PS-1	A student who needs to translate academic content and research materials.	Translate text accurately and quickly between multiple languages for assignments and international collaboration.	Existing translation tools often provide literal translations and fail to capture contextual meaning.	Many platforms rely on basic rule-based or statistical methods instead of advanced AI models that understand context and tone.	Frustrated, uncertain about accuracy, and less confident while submitting academic work.
PS-2	A working professional communicating with international clients.	Translate business emails and documents clearly and professionally.	Available online translators sometimes generate awkward or grammatically incorrect sentences.	They lack advanced AI-driven contextual understanding and domain awareness.	Unsure about communication quality and worried about professional credibility

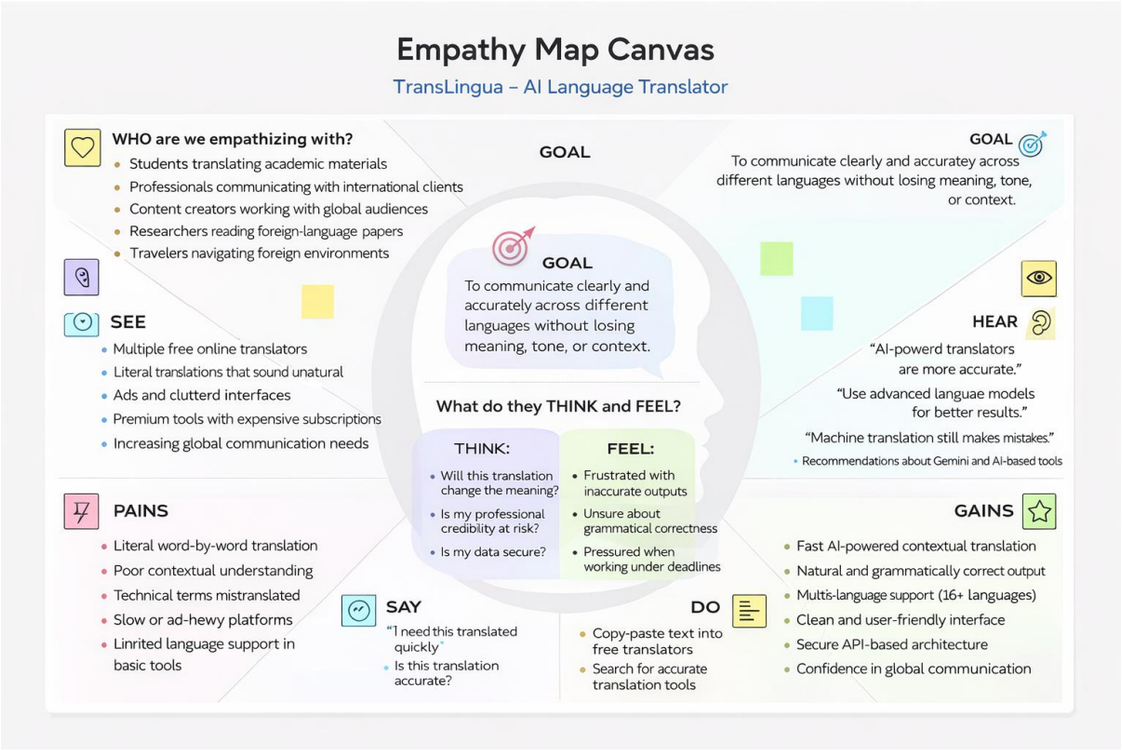
2.2. Empathy Map Canvas

Empathy Map Canvas:

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes.

It is a useful tool to helps teams better understand their users.
Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

Example:



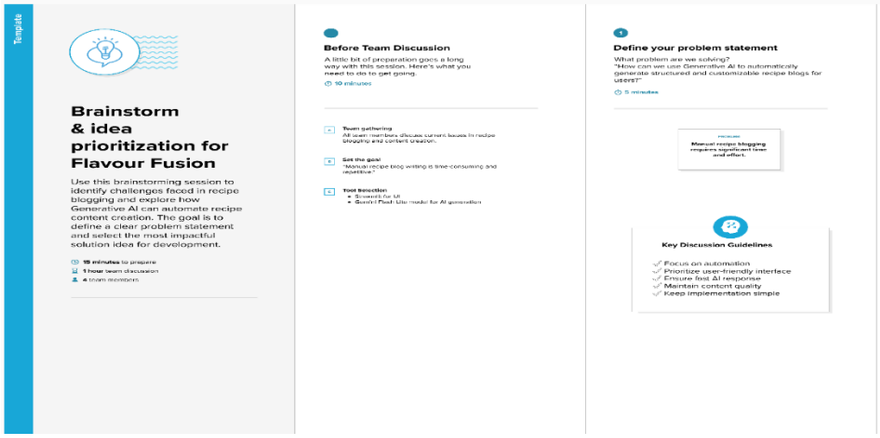
2.3 Brainstorming

Brainstorm & Idea Prioritization:

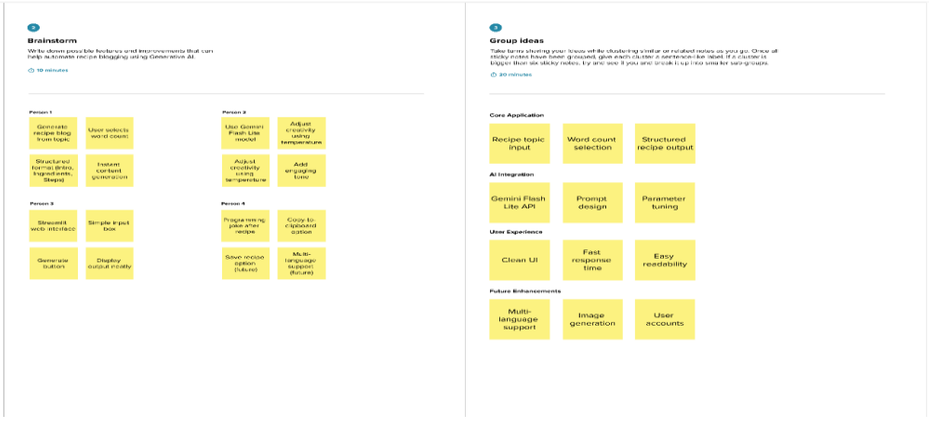
Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions.

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

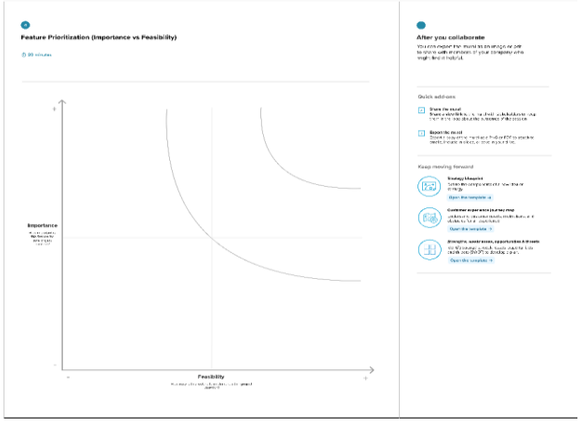
Step-1: Team Gathering, Collaboration and Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization



3. Requirement Analysis

3.1. Solution Requirement

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Text Input Module	Enter text to be translated Select source language Select target language
FR-2	Input Validation	Validate empty text input Ensure source and target languages are selected Display appropriate error messages
FR-3	AI Integration	Connect to Google Gemini API Send structured translation prompt Handle API response and fallback if needed
FR-4	Translation Processing	Generate context-aware translated text Preserve tone and meaning
FR-5	Output Display	Display translated text in UI Enable copy-to-clipboard feature
FR-6	Deployment	Deploy application on Streamlit Cloud Make application accessible via URL

Non-functional Requirements:

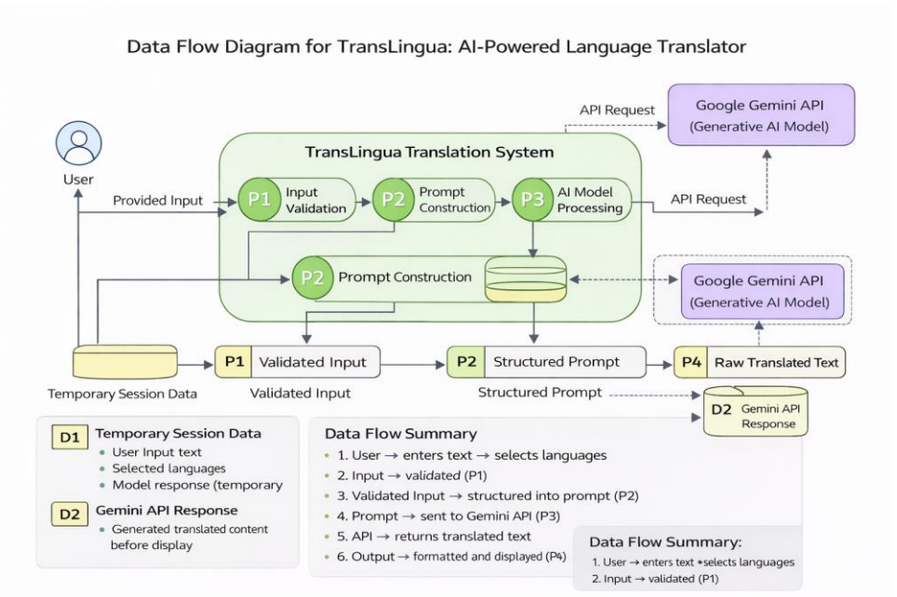
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The application must have a simple and intuitive Streamlit interface that is easy to use.
NFR-2	**Security**	API keys must be securely stored and not exposed in the frontend.
NFR-3	**Reliability**	The system should generate consistent and structured outputs for valid inputs.
NFR-4	**Performance**	Translation should be generated within a few seconds under normal network conditions.
NFR-5	**Availability**	The application should be accessible online whenever deployed.
NFR-6	**Scalability**	The system should handle multiple users without significant performance degradation.

3.2. Data Flow Diagram

Data Flow Diagrams:

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



User Stories

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	User Interface Setup	USN-1	As a user, I can access a Streamlit-based interface to enter text and select source and target languages.	I can enter text and choose languages successfully.	High	Sprint-1
Administrator	Input Validation	USN-2	As a user, I want the system to validate my input text and selected languages before translation.	I receive validation messages for empty or incorrect inputs.	High	Sprint-1
System	AI Model Integration	USN-3	As a user, I want the system to translate text using the Google Gemini API.	The system successfully integrates with Gemini and returns translated text.	High	Sprint-2
Administrator	Prompt Engineering	USN-4	As a developer, I want to construct structured prompts to ensure contextual and accurate translation.	Prompts are correctly formatted and produce context-aware translations.	Medium	Sprint-2
Customer (Mobile user)	Output Display	USN-5	As a user, I want to view the translated text clearly on the screen.	Translated output is displayed in a readable format.	High	Sprint-3
Customer Care Executive	Deployment	USN-6	As a developer, I want to deploy the	successfully deployed and	Medium	Sprint-3

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
			application on Streamlit Cloud so users can access it online.	accessible via URL.		

3.3. Technology Stack

Technical Architecture:

The Deliverable shall include the architectural diagram as below and the information as per the table1 & table 2

Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	Web-based interface where users enter text and select source and target languages	Streamlit (Python Web Framework)
2.	Application Logic-1	Input validation and prompt construction logic	Python
3.	Application Logic-2	AI request handling and response processing	Google Generative AI API
4.	Application Logic-3	Translation formatting and output structurin	Python
5.	Temporary Data Handling	Stores user input and session data temporarily	Streamlit Session State
6.	External API-1	Generative AI service for language translation	Gemini 2.5 Flash (models/gemini-2.5-flash)
7.	Machine Learning Model	Pre-trained generative AI model for contextual translation	Google Gemini Model
8.	Infrastructure (Server / Cloud)	Deployment of application	Streamlit Cloud / Local Deployment

Table-2: Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	Web framework and development tools used	Streamlit, Python
2.	Security Implementations	Secure storage of API keys and environment variables	Environment Variables (.env), Streamlit Secrets
3.	Scalable Architecture	Web-based architecture supporting multiple users	Cloud-based deployment (Streamlit Cloud)
4.	Availability	Application accessible online after deployment	Streamlit Cloud Hosting
5.	Performance	Fast response generation using lightweight AI model	Gemini Flash Lite (optimized for low latency)

4. PROJECT DESIGN

4.1. Problem Solution Fit

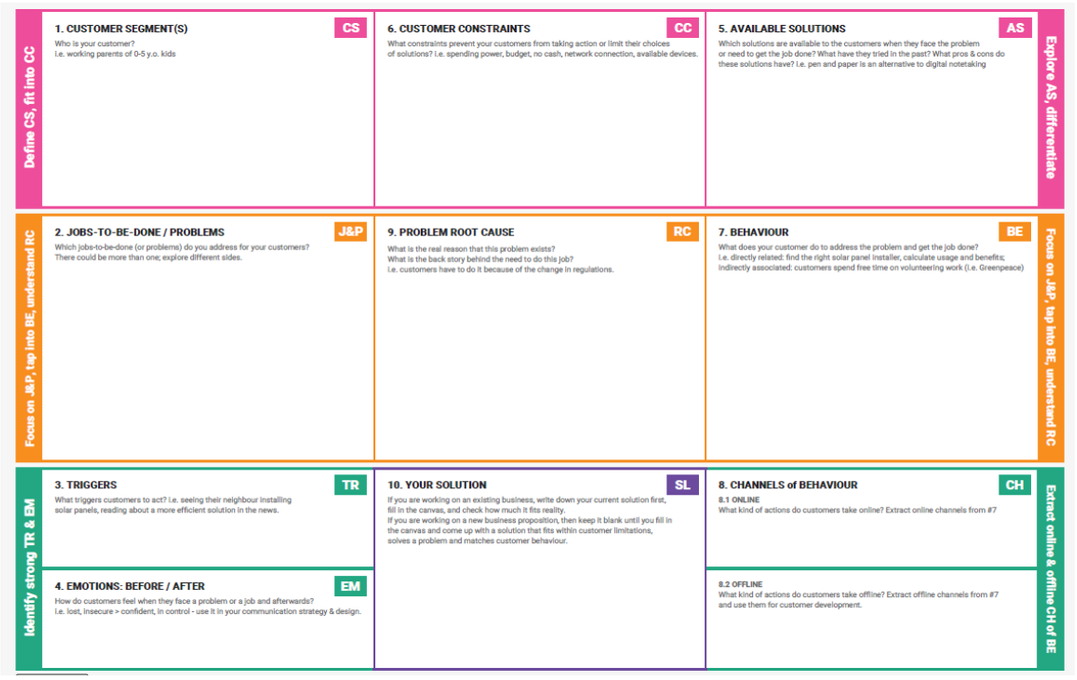
Problem – Solution Fit Template:

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioral patterns and recognize what would work and why

Purpose:

- ❑ Solve complex problems in a way that fits the state of your customers.
- ❑ Succeed faster and increase your solution adoption by tapping into existing mediums and channels of behavior.
- ❑ Sharpen your communication and marketing strategy with the right triggers and messaging.
- ❑ Increase touch-points with your company by finding the right problem-behavior fit and building trust by solving frequent annoyances, or urgent or costly problems.
- ❑ **Understand the existing situation in order to improve it for your target group.**

Template:


Define CS, fit into CC
1. CUSTOMER SEGMENT(S)
CS
Who is your customer?
I.e. working parents of 0-5 y.o. kids
6. CUSTOMER CONSTRAINTS
CC
What constraints prevent your customers from taking action or limit their choices of solutions? I.e. spending power, budget, no cash, network connection, available devices.
5. AVAILABLE SOLUTIONS
AS
Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? I.e. pen and paper is an alternative to digital notetaking
Explore AS, differentiate
Focus on J&P, tap into BE, understand RC
2. JOBS-TO-BE-DONE / PROBLEMS
J&P
Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.
9. PROBLEM ROOT CAUSE
RC
What is the real reason that this problem exists?
What is the back story behind the need to do this job?
I.e. customers have to do it because of the change in regulations.
7. BEHAVIOUR
BE
What does your customer do to address the problem and get the job done?
I.e. directly related: find the right solar panel installer, calculate usage and benefits; Indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)
Focus on J&P, tap into BE, understand RC
Identify strong TR & EM
3. TRIGGERS
TR
What triggers customers to act? I.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news.
4. EMOTIONS: BEFORE / AFTER
EM
How do customers feel when they face a problem or a job and afterwards?
I.e. lost, insecure > confident, in control - use it in your communication strategy & design.
10. YOUR SOLUTION
SL
If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.
If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.
8. CHANNELS of BEHAVIOUR
CH
8.1 ONLINE
What kind of actions do customers take online? Extract online channels from #7
8.2 OFFLINE
What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.
Extract online & offline CH of BE

4.2. Proposed Solution

Proposed Solution Template:

Project team shall fill the following information in the proposed solution template.

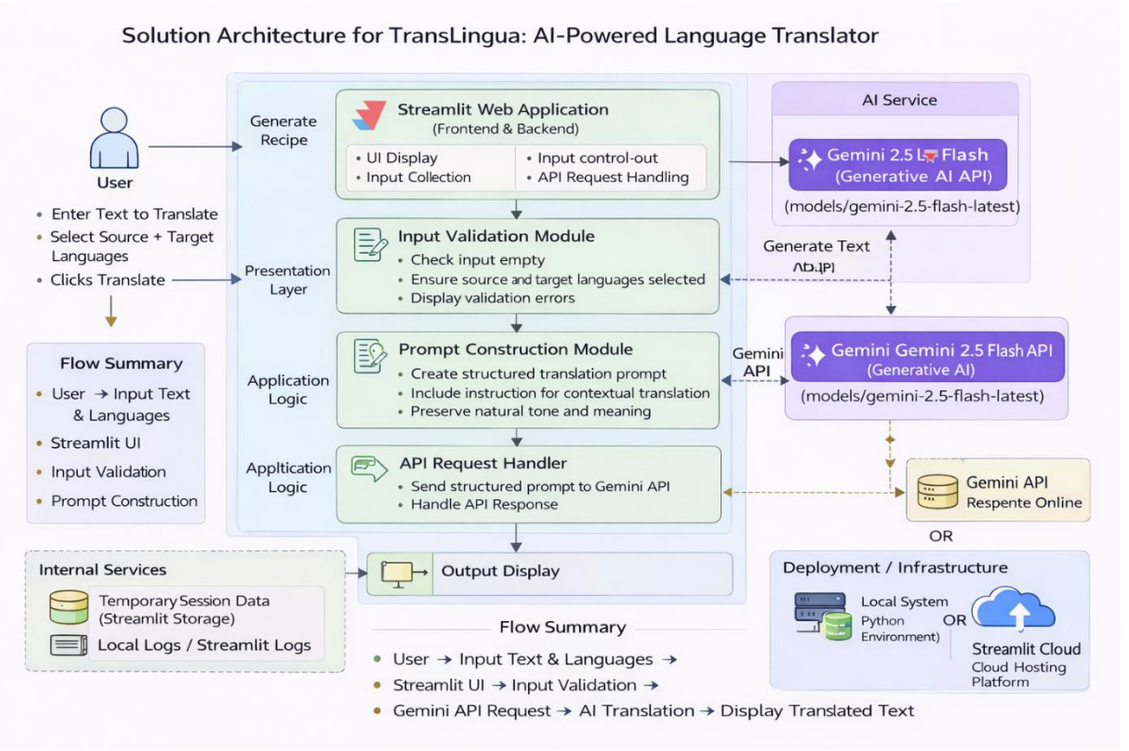
S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Many students, professionals, and global users struggle to communicate effectively across different languages. Existing translation tools often provide literal translations, lack contextual understanding, and sometimes produce grammatically incorrect or unnatural outputs. There is a need for an AI-powered system that delivers accurate, context-aware, and fast translations through a simple and user-friendly interface..
2.	Idea / Solution description	TransLingua is an AI-powered web application that translates text between multiple languages using Google's Gemini 2.5 Flash model. Users enter text, select source and target languages, and receive context-aware translations instantly. The system constructs structured prompts and processes them via the Gemini API to generate accurate and natural-sounding translations through a clean Streamlit-based interface.
3.	Novelty / Uniqueness	Unlike traditional rule-based translators, TransLingua leverages advanced Generative AI to understand context, tone, and meaning rather than translating word-by-word. The system dynamically generates natural translations in real-time and provides a modern, responsive interface with secure API integration.
4.	Social Impact / Customer Satisfaction	The solution enhances global communication by enabling students, researchers, professionals, and travelers to translate content accurately and efficiently. It improves productivity, reduces misunderstandings, and builds confidence in multilingual communication. The simple interface makes advanced AI translation accessible to non-technical users.
5.	Business Model (Revenue Model)	The application can adopt a freemium model where basic translation is free, and advanced features (higher request limits, document translation, tone customization, enterprise API usage) are available through subscription plans. Revenue can also be generated through API licensing or enterprise integration.
6.	Scalability of the Solution	The application is cloud-deployable and uses a scalable generative AI API. It can handle multiple users simultaneously when deployed on cloud infrastructure.

4.3 Solution Architecture

Solution Architecture:

The solution architecture of TransLingua consists of a Streamlit-based web application that collects user input (text, source language, and target language) and validates it. The application constructs a structured translation prompt and sends it to the Google Gemini 2.5 Flash generative AI model through a secure API call.

The AI model processes the request and generates context-aware translated text. The application then formats the response and displays it clearly to the user. Temporary session data is managed using Streamlit Session State. The system can be deployed locally or on a cloud platform such as Streamlit Cloud



5.PROJECT PLANNING & SCHEDULING

5.1. Project Planning

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	User Interface Setup	USN-1	As a user, I can access a Streamlit-based interface to enter text and select source and target languages.	2	High	All Team Members
Sprint-1	Input Validation	USN-2	As a user, I want the application to validate text input and language selection before translation.	1	High	All Team Members
Sprint-2	AI Model Integration	USN-3	As a user, I want the system to translate text using Google Gemini 2.5 Flash model.	3	High	All Team Members
Sprint-2	Prompt Engineering	USN-4	As a developer, I want to construct structured prompts for context-aware translation	1	Medium	All Team Members
Sprint-3	Output Display	USN-5	As a user, I want to view the translated text clearly on the screen.	2	High	All Team Members
Sprint-3	Deployment	USN-6	As a user, I want the application to be deployed and accessible online.	2	Medium	All Team Members

Project Tracker, Velocity & Burndown Chart: (4 Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint 1	20	4 Days	28 January 2026	31 January 2026	20	31 January 2026
Sprint 1	20	4 Days	28 January 2026	31 January 2026	20	31 January 2026
Sprint 2	20	8 Days	02 February 2026	09 February 2026	20	09 February 2026
Sprint 2	20	8 Days	02 February 2026	09 February 2026	20	09 February 2026
Sprint 3	20	7 Days	12 February 2026	18 February 2026	20	18 February 2026
Sprint 3	20	7 Days	12 February 2026	18 February 2026	20	18 February 2026

6. FUNCTIONAL AND PERFORMANCE TESTING

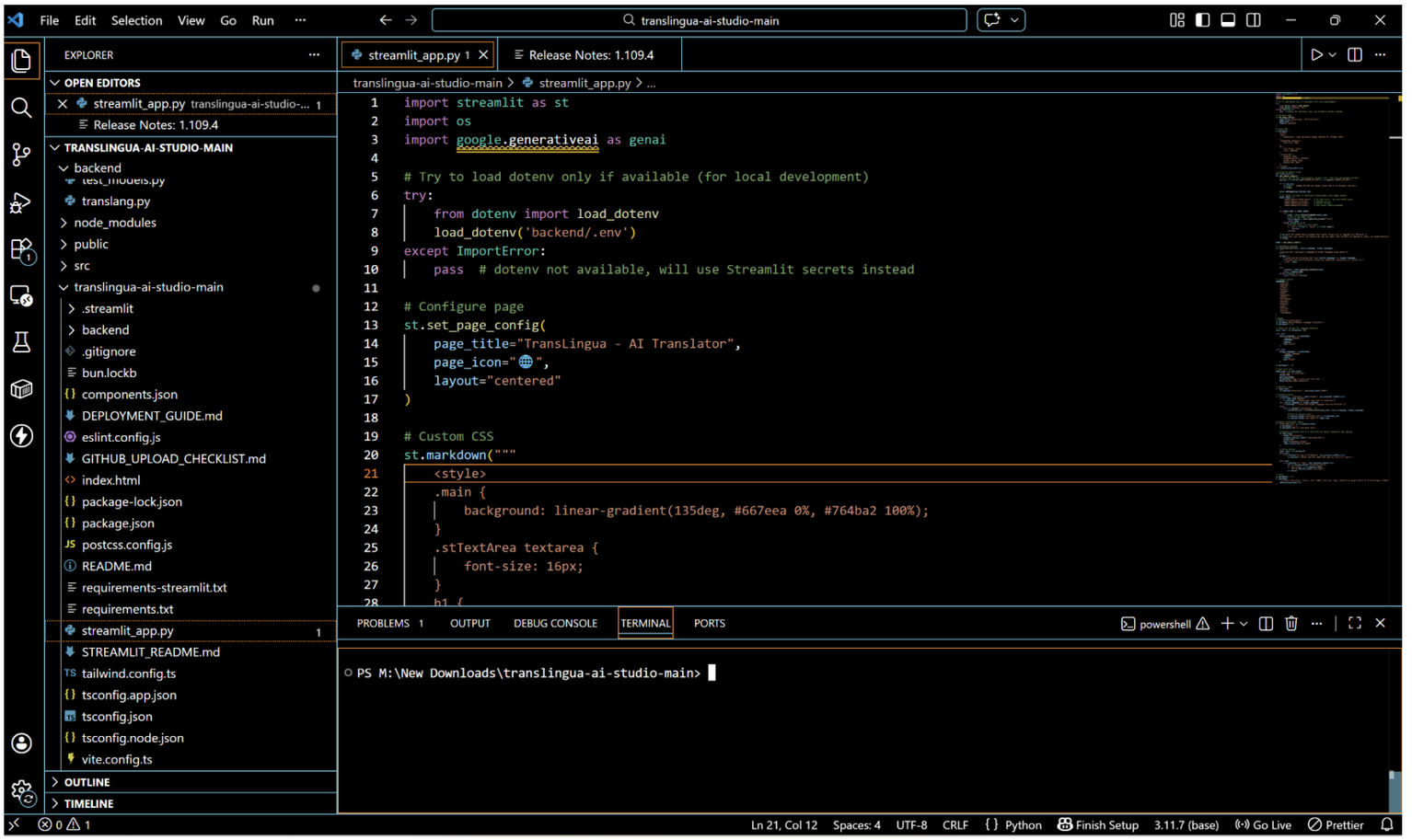
6.1 Performance Testing

Test Scenarios & Results

Test Case ID	Scenario (What to test)	Test Steps (How to test)	Expected Result	Actual Result	Pass/Fail
FT-01	Text Input Validation	Enter valid text and try submitting with empty input	Valid input accepted, error shown for empty input	As Expected	Pass
FT-02	Language Selection Validation	Select source and target languages, try leaving one unselected	System shows validation warning if languages not selected	As Expected	Pass
FT-03	AI Translation Generation	Enter text and click “Translate””	Context-aware translated text generated correctly	As Expected	Pass
FT-04	Gemini API Connection Check	Trigger translation with valid API key	API responds successfully and returns translation	As Expected	Pass
FT-05	Copy-to-Clipboard Feature	Generate translation and click copy button	and click copy button Translated text copied successfully	As Expected	Pass
PT-01	Response Time Test	Measure time after clicking generate	Translation generated within 3–5 seconds	Within Limit	Pass
PT-02	Multiple Request Handling	Perform multiple translations sequentially	Application handles requests without crash	Stable	Pass
PT-03	Deployment Test	Access deployed app via browser	Application loads and works correctly online	Working	Pass

7. RESULTS

7.1. Output Screenshots



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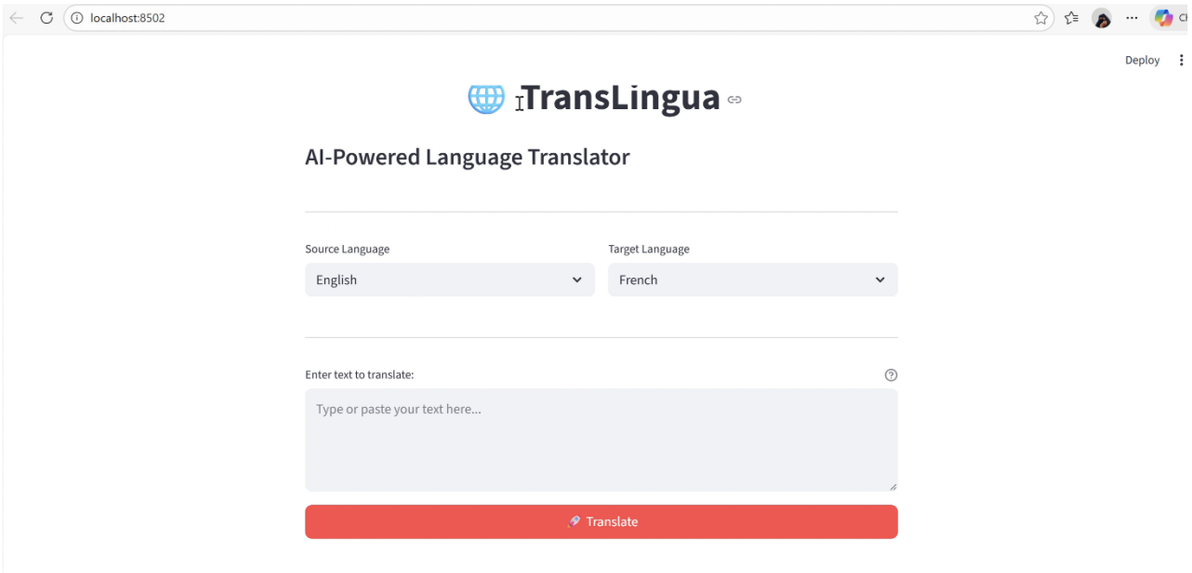
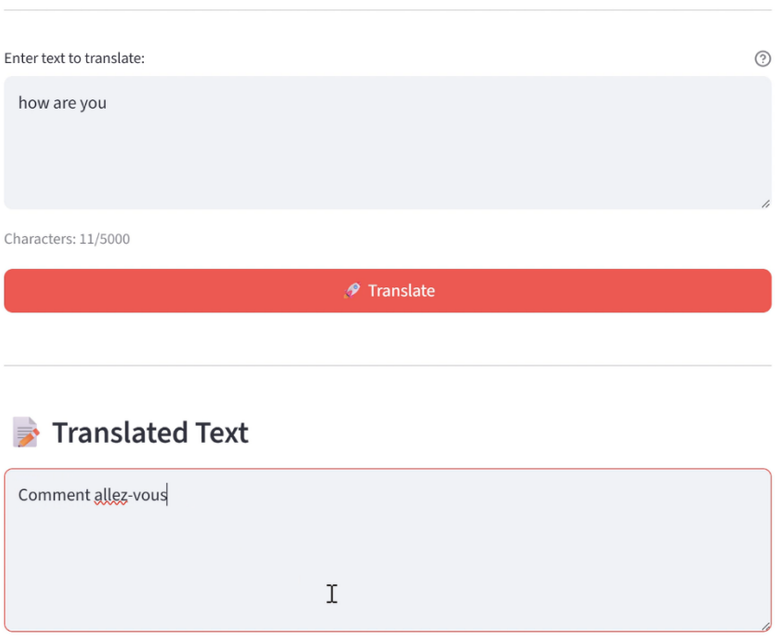

localhost:8502
Deploy
TransLingua
AI-Powered Language Translator
Source Language
English
Target Language
French
Enter text to translate:
Type or paste your text here...
Translate


Enter text to translate:
how are you
Characters: 11/5000
Translate

Translated Text
Comment allez-vous

8. ADVANTAGES AND DISADVANTAGES

Advantages

- Saves time with instant AI-powered language translation
- Reduces manual effort in translating text across languages
- Provides context-aware and natural translations
- Supports multiple global languages
- User-friendly interface built with Streamlit
- Fast translation using pre-trained Gemini 2.5 Flash model
- No need for dataset collection or custom model training

Disadvantages

- Requires an active internet connection
- Depends on third-party AI APIs (Google Gemini)
- Limited to text-based translation (no voice/image translation in current version)
- Output quality may vary depending on clarity and complexity of input text
- API usage limits may apply under free-tier plans

9. CONCLUSION

The **TransLingua: AI-Powered Language Translator** project successfully demonstrates how generative AI can be utilized to enable accurate and context-aware multilingual communication. The application allows users to translate text between different languages by selecting the source and target languages, significantly reducing the time and effort required for manual translation. By integrating a pre-trained generative AI model (Google Gemini 2.5 Flash) with a simple and user-friendly Streamlit interface, the project delivers fast, reliable, and natural-sounding translations, making it a valuable tool for students, professionals, researchers, and global users.

10. FUTURE SCOPE

The **TransLingua** project can be further enhanced by incorporating additional language support to expand global accessibility and reach a wider audience. Future improvements may include adding **voice-to-text and speech-to-speech translation**, enabling users to translate spoken language in real time. Introducing **document translation (PDF, Word files)** would allow users to translate complete documents instead of only text input.

Adding **user authentication and accounts** would enable users to save translation history and access it later. The system could also provide **personalized translation suggestions**, tone adjustments (formal/informal), and domain-specific translations (technical, business, academic). Additionally, deploying the application as a **mobile app** or integrating it with messaging platforms would make the solution more convenient, accessible, and user-friendly across different devices and environment

11. APPENDIX

11.1. Source Code

The source code for the TransLingua: AI-Powered Language Translator project includes the implementation of the Streamlit-based user interface, integration of the Google Gemini 2.5 Flash model using the Google Generative AI API, translation prompt construction logic, and output formatting functionality. The application handles user input validation, API communication, and response processing to generate accurate and context-aware translations. The code is written in Python and follows a modular, structured, and readable approach to ensure maintainability and scalability.

11.2. Github & Project Demo Link

Github Repository Link: https://github.com/ayeshasheik611/TransLingua-AI-Powered-Multi-Language-Translator-.git

Demo Link: https://drive.google.com/file/d/1xIqBx0-uOsE3Z3WVbOKXsGq7hEA9Lg4Z/view?usp=drive_link