Smitha S P - (ISE_45) Capstone_Project_Report(from abstract to appendix)

by Smitha S P

Abstract

"Conversational Agent Based Ticketing System for Museums Using AI Technology". This project "AI-Based Chatbot Supported Museum Online Ticket Booking" will develop a smart online ticket booking system which is an alternative to ticket lines in museum and cultural centers. Utilizing (NLP) Natural Process Language and conversational AI, it allows visitors to engage with a bot just as they would conversationally booking tickets, reservations and finding exhibition information instantly. The solution is aimed to remove long lines, decrease manual mistakes and offer a smooth visitor experience with the help of multi-lingual user friendly interface.

It is a very simple system, yet it delivers accurate results fast and reliably. The chatbot interface is designed not only for general audiences of all literacy levels, but also to be inclusive. It serves multiple languages in hopes to accommodate local and international visitors. It presents encrypted payment gateways for contactless, secure payments and real-time analytics for museum owners to monitor footfall, ticket sales and event engagement.

Focus and Prompt payment, Compliance with new data protection laws so that visitor and finance information is it safe from theft. Lastly – and most importantly, we get that because having better experiences matter so much for cultural organizations. visit Method Inse pulls together all this info at runtime for people who want it and lets them choose their option, not be forced to choose. Through the combination of technology and cultural heritage, this project will contribute to open up museums to all.

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Abbreviations

Abbreviation	**Full Form**
AI	Artificial Intelligence
NLP	Natural Language Processing
STT	Speech-to-Text
TTS	Text-to-Speech
NER	Named Entity Recognition
DB	Database
QR	Quick Response
UI	User Interface
UX	User Experience
REST	Representational State Transfer
TLS	Transport Layer Security
SSL	Secure Sockets Layer
PCI-DSS	Payment Card Industry – Data Security Standard
GDPR	General Data Protection Regulation
JWT	JSON Web Token
RBAC	Role-Based Access Control
VM	Virtual Machine
WCAG	Web Content Accessibility Guidelines
SDGs	Sustainable Development Goals
AR	Augmented Reality

Chapter 1

INTRODUCTION

Outdated ticketing systems have made it difficult to manage large volumes of service requests in businesses, schools and government offices. Legacy helpdesks – built on email threads, ad-hoc logging, call driven complaints and fragmented CRM systems – drive slow responses, lost tickets, bad triaging and can incur as much as 30% more support overhead but without giving backlog a real-time customer view.

In the beginning there are many digital transformation projects we witness in various spaces and as a number of orchestrations build up there is an increasing melody for "Online Chatbot-Based Ticketing System" to automate ticket creation, universal dashboards and integration with ERP systems, ITSM initiatives and workflow systems. AI powered conversational chatbots assist with 24×7 support, intelligent query routing, NLP driven issue classification, up-to-date status updates and contact deflection. This turns ticket management from being reactive, human led support to proactive, scalable service delivery based on data – lower time to resolution, reduced operational overhead and higher end user satisfaction and enterprise productivity.

Service operations must be data driven to be efficient, however manual ticketing systems often lack actionable analytics. It persists system call histories, resolution behavior, distributed workloads and user satisfaction scores for an Online Chatbot-Based Ticketing System. Consolidated dashboards assist admins in zeroing in on patterns of issues, maximize resource allocation and policy changes. The system is additionally enriched through the use of machine learning models that predict query categories, suggest solutions and help to lower an average resolution time – changing support from reactive to predictive. With increasingly varied digital tools being adopted by businesses, scale and integration are key. Test a bot-driven ticketing system A ticket chatbot solution can easily integrate with all types of CRM software, ERP applications, inventory programs, ITSM systems and cloud-based databases over enough APIs. This results in automatic data exchange (assets details, user profiles, service history and contracts (SLAs)) without human mediation. As a result, support teams have full context so they can react faster with less effort and more accurate escalation between departments.

1.1 Background

The Tourism sector is witnessing a huge transformation with the development of digital technologies which also result in changes of users expectations. New visitors in particular, particularly the younger tech-literate generation, now take instantaneous information and online services for granted – and demand personalised digital experiences across every industry, be it retail or travel, gaming or education. When they go to the museum, they want it all to be just as simple and intuitive.

But in most museums, old-school approaches (hand-cranked ticket turnstiles, printed brochures, people-driven information kiosks) are still used today. While such mechanisms are useful, they suffer from scalability issues and may not respond to many different types of visitor inquiries as fast or accurate as is desired. Queues, ticket category confusion and lengthy verification processes are among the things that can drastically hinder the visitor experience. The stakes are even higher for those pressed for time or visiting the museum for the first time and who do not know where they are going.

At the same time, advancements in conversational AI, cloud and intelligent automation have unlocked new opportunities across the service industry. The rise of chatbots, virtual assistants and cloud management systems is shaking up how companies interact with people — whether they are staff members or customers — by making that communication more human on the fly. The museums could also benefit from these technologies, leading towards an intelligent environment that would be more "confident" and operated in synch with visitors.

The idea isn't to remove that human-to-digital interaction completely, but for with the right 'AI' museum assistant you can automate these predictable interactions – quickly point a visitor in the right direction within your venue, streamline their ability to purchase tickets and present tailored suggestions based on visitors' interests. This reduces strain on their staff but provides the visitor with a more intelligent, always-on, know-what-you-want digital companion that can simplify information in an intuitive dialogue-like manner. These are game changers in the worldwide move toward smart cultural sites, and they enable museums to meet the needs of tourism that is future-ready.

1.2 Statistics

The literature on tourism and cultural heritage now allows such a correlation between visitor satisfaction an museum management system to be assumed. Analysis Absolutely zero reasonable analysis that already more than 60% of all disappointed customers worldwide inside any major museums would be linked to (1) too long waiting composite with (2) non transparent ticketing and again coming up with another one under (3) insufficient support for international visitors in their language. Such concerns are not just annoying, but also diminish the time visitors have to spend with exhibits and learn from them.

With the emergence of digital services, museums that have switched to automated or semi-automated ticketing systems have noted significant enhancement in staff flow. Studies have shown that by introducing AI-driven chatbots and virtual assistant, waiting times can be reduced up to 40% with automation of common questions like ticket pricing, exhibits details, hours of operation, directions etcetera. The decrease was a big factor in improving the flow of visitors, reducing lines at counters, and time needed for tourists to make decisions.

In addition to it, some researches carried out in smart-tourism environments show that AI-enabled ticketing and visitor management systems can improve overall engagement with personalization recommendations and interactive assistance. These systems are capable of managing thousands of concurrent transactions, so no guest ever feels neglected even in peak seasons. Their scalability, reliability and ability to integrate form the perfect solutions for today's forward-thinking museums that want to improve visitor engagement while streamlining operations.

Taken together, these numbers represent a strong case for why museums need smart, automated systems. AI enables museums to move away from siloed visitor services, towards experiences that are responsive, adaptive and user centred – that meet the needs of digital first travellers.

1.3 Prior Existing Technologies

Conventional museum ticketing and visitor support systems are mainly developed on static websites, simple mobile apps or desktops based desk interactions. And while they offer users an opportunity to see hours, explore exhibits or buy tickets, many of these kinds of apps are organized in a linear fashion -think of them as one-way streets and not two-ways. This requires visitors to have to drill down through layers of pages or menus in order to find what they're looking for which can be frustrating, particularly if you're a first-time user or an international tourist who might not understand how the museum is organized.

To date, some museums have tested simple, rule-based chatbots and implemented them into their websites or mobile applications to bring museum collections closer towards the digital edge. Most of them are based on pre-recorded scripts and decision trees that can answer to only specific keyword-based requests. While they automatically process a few visitors, they are severely limited in their capabilities. They are unable to contextualize the conversation, personalize and change according to user's preference and acknowledge with a natural feel for the diverse forms of query. For instance, a rule-based bot should respond to "What are timings for today?" but have trouble with the more flexible queries such as "I only have an hour what exhibits do I need to see first?

And many of the systems already in place are not multilingual, which means that they do not work for international travelers who would like to receive digital services in their own language. They offer limited, if any, on-demand personalization so they can't suggest exhibitions a visitor might like to see based on visitor interest, age range, ticket type or what visitors previously said they liked. Moreover, existing ticketing apps hardly incorporate smart features such as queue predictions, explanations of dynamic city pricing or location-based assistance at the museum facility.

The constraint they represent is a clear technology challenge that the museum field confronts. What's clear is that a smarter, responsive and more user-friendly solution is needed – one that goes beyond just automation to the point where the visitor is given control. The paper presents a novel AI-based museum chatbot that fills this gap by exploiting state-of-the-art Natural Language Processing (NLP), conversational intelligence and cloud-based scalability to enable natural support, context-aware conversations and device-independent, multi-lingual behaviour.

1.4 Proposed Approach

The system provides a smart integrated chatbot, aiming at transforming and simplifying visitor experience in museum environment. Fundamentally, It's built on NLP (Natural Language Processing) which makes natural conversations and user queries readable and comprehensible to the software engine make it look conservative towards any visitor interacting with the system like an actual human being. Rather than using a set of Bill plans offered to all users, simply present the conversational agent as an interface that is flexible enough to answer questions asked in diverse ways and tailor its response based on what information it has gathered about the visitor's purpose.

Making the complete solution cloud-based guarantees high availability and continuous performance. This ensures that the system can easily scale to thousands of concurrent transactions, quickly and without incident around peak time. The platform also features payment gateways, which allows users to book tickets securely and quickly from the chat environment. Upon booking, the system provides QR-coded digital tickets instead of paper tickets and facilitates quick entry validation at the museum.

Apart from booking tickets, the chatbot also acts as an intelligent assistant. With the aid of recommendation algorithms, it is able to recommend eligible exhibitions, events and galleries by user interests, age group, available timing or historical preferences. This guarantees that each visitor, whether they are a student, a tourist, an art lover or someone just passing through, gets their own unique museum experience.

For better accessibility, system also offers voice interaction which makes the website quite easily accessible to its visitors who don't feel friendly or may have low digital literacy. . What's more, you can use it multilingually if you want that international visitors meet in their mother language and have a barrier-free navigation which enhances your museum experience.

Taken together, these components provide for a unified and intelligent UI(System) interaction, that not only automates repetitive tasks but also enriches the experience of the visitors through delivering instant, trustworthy and useful support.

1.5 Objectives

To this aim, we present a method in which an active dialogue system is used to assist both the visitors and the curators. The solution will involve the application of cutting-edge technologies such as NLP, cloud computing and secure digital services to displace how museums traditionally operate with a low-friction, high-accessibility & interactive digital presence. The key objectives include:

Objective 1 – Automation of the Way Tickets are Booked

Objective This aim aims at automation in checking manual queues and to cut the dependence on ticket check counters by allowing users to book, update or destroy their logs using this chatbot. Automating this process allows for quicker service and better visitor circulation during high traffic times.

Objective 2: Multi-Lingual and User-Friendly Interface Development

The system should potentially include multiple languages in order to make it possible for both local and tourists or students from other country, to communicate with the chatbot. The user interface is basic and easy to use so that even those who struggle with the more modern digital graphics and options will be able to access the range of services available at the museum.

Objective3: Recommendation of Personalized Visitors.

The chatbot will also leverage recommendation algorithms to offer personalized recommendations according to personal interests, available time and past interaction. It encourages visitors to experience the museum more conscientiously and use time better.

Objective 4: Voice-Based Interaction to Accessibility

This objective introduces a way of using for the users with voice that allows them to achieve an all-participant system. The oral support is particularly valuable to people who find typing or have low digital literacy, making the site even more accessible to anyone.

Objective 5: Build in safe and touchless transactions

Therefore, they would like to integrate familiar and secure payment gateway into their chatbot tool. It is a simple, hassle-free and sanitary method of enabling your customers to make transactions without placing themselves into contact or long lines at point-of-sale.

Objective 6: Analytics for Museum Management in Real Time

Another goal is to help museum authorities by providing analytical reports including the type of visitors, ticket sales, busiest hours and commonly asked questions. These provide operational planning and decision support in real time.

Objective 7: Guarantee High Scalability in Rush Hours or Special Events

The system is capable of managing high-volume concurrent interactions, particularly during special exhibitions, weekends, and holidays. It is this aim which ensures the performance and reliability of the system even under heavy load.

1.6 Sustainable Development Goals (SDGs)

This project is highly relevant to many of the United Nations Sustainable Development Goals (SDGs) and makes a significant contribution to international efforts in building inclusive, resilient and tech-centered societies. By digitalizing the museum and modernizing experience of it through clever robotics and digitization, the system contributes substantially to several SDGs.

Fig 1.1 Sustainable development goals

SDG 9: Industry, Innovation and Infrastructure

It encourages high technology content through previous tools such as NLP, cloud computing, digital ticketing and AI based recommendation systems. They bring museaums into the modern era of infrastructure and show how cultural organizations can embrace smarter, scalable digital tools that enhance operations and public experiences. An example of sustainable digital transformation, the project has improved operational workflows with reduced resource consumption.

SDG 4: Quality Education

And museums are very important in the development of culture and education. Via personalised exhibit recommendations, multi-language support and screen reader accessibility to enable voice interaction the system provides access to knowledge for everyone, regardless of age or background or disability. It supports directly the Inclusivity (visits every school in Edinburgh once before leaving primary, 50/50 gender balance) and equity of culture learning by extending this provision outwith the eLearning audience to a participatory audience that is inclusive of international tourists and with reduced digital literacy.

SDG 11: Sustainable Cities and Communities

Digitizing the ticketing system and minimizing dependency from paper-based industry, the project contributes to environment-friendly tourism and cultural management. The automatic visitor service of the present invention provide museum visitors with convenient and fast receiving services, so as to facilitate the usage and access of visitors in the museums, decrease traffic congestion and increase attractiveness of urban culture. The service is environmental friendly and support green tourism by providing contactless, more efficient, healthier and eco-friendly alternatives to traditional methods.

1.7 Overview of project report

In this paper, we provide a complete documentation on This paper provides a full report on the AI-Powered Museum Assistance and Ticketing System from its conception stage to its implementation phase and further evaluation and plans for future improvement. This is what I aim to cover in the following chapters collectively: the context of the problem, technical background behind my system, how it was developed and finally what I hope this project has contributed.

Chapter 1 provides and Introduction to the project. It presents the background of the ongoing project, its motivation, and discusses why museums have a growing demand for digital transformation. Descriptive statistics on theme park visitors are presented which make clear how numerous challenges faced by the visitor existed such as long waiting times, language barriers and slow ticketing. It discusses the state of the art along with its shortcomings, outlines AI oriented proposal, sets project objectives and examines the progressive perspective through which it relates to Sustainable Development Goals (SDGs) of United Nations while introducing the whole report.

Chapter 2 offers a literature review that addresses the state of the art in academic research and previously proposed solutions linked to conversational AI, museum automation systems, cloud-based ticketing platforms technologies, NLP methodologies and recommendation algorithms. The review consolidates research results, commercial software and future directions to cover existing work and voids on which the proposed chatbot will particularly focus (in understanding context, being personalizable or working in multiple languages).

Chapter 3 describes the methodology used for developing the system. It describes the phased method of need analysis, system analysis, architectural design, NLP based model development, cloud deployment designs and iterative testing. This chapter illustrates how every stage of the development is coherent with the purpose of each phase and ensures a linear process from idea to creation.

Chapter 4 project management topics such as inventory planning, resource allocation, time scheduling with Gantt diagrams and risk-management are covered. This includes examining risks and problems of a technological, operational, and environmental nature with the introduction into public cultural spaces of systems on the basis AI. Budgeting and costing are also written up to demonstrate the practibility of big scale application.

Chapter 5 Systems Analysis and Design. In this chapter, we also describe how NLP processing, ticket management, voice assistance, payment integration and recommendation modules collaborate in our system. The design diagrams, flowcharts and interface mockups offer a solid technical map for the solution.

Chapter 6 discusses the implementation history – i.e., it describes how individual modules were implemented and combined. This encompasses setting up the development environment, building the chatbot logic, integrating payment gateways, configuring cloud storage services and deploying support for multiple languages or speech. Code snippets, API configuration and system screenshots aid to support the hands-on development sections. Show Dialog ("Defining an active state dialogue"); Misc.

Chapter 7 discusses the system testing and evaluation. It explains a test plan regarding the functional, usability, performance and security testing. The results from a series of test cases, such as successful extraction of tickets, response accurateness, scalability tests and chatbot conversational correctness are presented along with observations. System performance, limitations, and further improvements are also addressed in this chapter.

Chapter 8 considers the social, ethical and sustainability implications of the Project. It measures how seriously companies take data privacy its considerations, ethical use of AI, digital inclusion for non-tech oriented visitors and accessibility to differently abled users. The chapter also raises issues of environmental benefits (like less use of paper for tickets using digital technologies) and considers how the system can support sustainable cultural tourism and responsible digital engagement.

Chapter 9 provides a summary of the project development process and the results as compared with our aims, and also discusses how we anticipate that the system will support museums in enhancing their operations and visitor experiences. It also discusses future developments around AR navigation, more advanced analytics dashboards, broader multilingual support and even more personalization being driven via machine learning algorithms.

Chapter 2

LITERATURE REVIEW

During the last decade, there has been a growing number of conversational agents, museum automation technologies and AI-based visitors assistance systems. We cover state-of-the-art in conversational AI, museum informatics, digital ticketing solutions, cloud deployment for cultural heritage, NLP-based personalization and smart tourism technologies. The review organizes information from several peer-reviewed papers and industry reports so we can explicitate deficits within current museum solutions that our AI-based MAS faces inmediate.

2.1 Virtual Museum Navigation Chatbots

Virtual museum tour chatbots are a novel integration of cultural heritage preservation, conversational AI and digitally useful tourism in the general sense. Beyond straightforward question answering, these systems serve as intelligent virtual guides—putting artefacts into context, explaining historical timelines and perspective, or personalizing recommendations based on a visitor's interests, prior knowledge or navigation behaviour. Nurtured by the DuBois Research Institute over six years, RECBOT embodies this transformation by fusing natural language understanding with recommendation logic to navigate museum collections on dynamic paths - instead of along static, curator-defined tours. This makes art accessible to those who cannot physically visit museums due to economic, geographical or physical reasons and helps democratize culture. In the era where museums are increasingly moving digital in the upcoming decade conversational agents like RECBOT may act as global and scalable cultural ambassadors, establishing a link between culturally different audiences across the globe with heritage institutions.

2.2 Early Conversational Museum Guides

Max, an early conversational museum guide that was a precursor to interactive cultural experiences. Max, as an in-person virtual buddy, demonstrated that people were also more likely to look deeper at exhibits and possibly ask questions when accompanied by a conversational interface, compared with static signage or listening to audio guides. Moreover, its existence verified central claims in human–computer interaction research—that conversation, social signals, and perceived personality contribute to enhanced learning, motivation, and emotional involvement with museum topics. Max also created interesting stats for curators on what people were interested in, what questions get asked the most and how people were navigating which illustrated the broader role of chatbots as instruments for learning and tools for data collection to help inform future planning of museum visit structures.

Zooming on Max in of today supports the possibility: a result born from its time, dictated by some technological limitation. The system was based on pre-defined dialog-trees and responses crafted by hand, with very little topic-coverage which resulted in repetitive conversation-patterns incapable of dealing with user-input not anticipated by the developers. But it was non-customizable, did not have interface localization capabilities and could not use images or video. Studies were also limited to small short term user groups, unable to draw conclusions concerning long-term use, its effects on learning, or its impact on accessibility. Today, with recent advances in NLP, computer vision and multimodal AI, Max could be reborn as an active narrative agent that senses the world through a camera device equipped to "see" exhibits, listens to natural speech and speaks back to users; dynamically adapts its user interaction depending on perceived knowledge level of user; and can provide distinct styles of narrative experiences. The combination of cloud-based analytics, recommendation engines, and universal design principles would additionally establish conversational guides as backbone elements of smart museums and immersive cultural tourism.

2.3 Persona-Based Museum Chatbots

Persona-based museum chatbots are a developing approach to improving user engagement and learning in cultural heritage organization. Noh et al. explored historical or artist-based chatbots, offering visitors to engage with exhibitions in a narrative-driven character based conversation style. This fosters the aspect of deeper immersion , curiosity and emotional connection because visitors do not think of the chatbot as an information system but as a context-specific storyteller. Artifacts Here and Now Laying out answers from recognizable/first-person perspective voice will enable characterization-based chatbots to enhance hypothetical labels, not to mention expand cultural interpretation. But the research also highlights several substantial challenges. To construct historically-accurate personas you need solid data, curator policing and constant material testing. That characterization can be inaccurate, culturally biased or a question of ethics — especially when talking about reports on underprivileged people and touchy historical subjects. Another difficulty is the chatbot would have to learn to keep a consistent narrative style (though, it would also be hard to retain little long-term memory in rule-based models, or generative models).

Next steps include structured knowledge graphs, museum ontologies, and fact-checking pipelines to maintain authenticity. Long term longitudinal user studies are recommended to investigate learning result, content recall as well as the portal's usability and visitor's satisfaction over a period of time. As conversational AI matures, persona-based museum chatbots may progress into scalable educational companions for hybrid physical-virtual museum visits sensitive to cultural and historical context.

2.4 Mobile Chatbot Tour Guide

Wang introduced a mobile chatbot system used as intelligent tour guide to enable the visitors communicating with museum exhibits based on their smartphones. The system combines image recognition with conversational interfaces — users can scan or take a photo of a piece of art, and then immediately see it identified and get to read tailored history on the artwork, details about its artist, what's going on in the pictures. This promotes self-exploration in an independent and uncover way, rather than rely on staff-led programs or static signage. On-actional feedback is also supported on chatbot, which lets past inputs impact recommendations in the future, and steers content delivery towards user's interests/preferences/browsing history.

However, the investigation exposed some functional limitations. Accurate matching between the encountered images and their corresponding exhibit metadata can be challenging, particularly in visually crowded gallery rooms, or when artworks share visual characteristics. Reliance on the network In addition, there is a limitation for the use of users because users will not be able to receive the internet signal depending upon if they're in a largemuseum building, thus affecting real-time chatbot responses. Moreover, the mechanism does not support multimodal interaction that beyonds text and simple image; also, it is very limited to linear interaction too.

Future prospective developments might include indoor positioning technologies such as Bluetooth beacons, Wi-Fi triangulation or visual SLAM for location aware guidance and better tour routing. (Arbitrary AR overlays might also be employed to offer immersive storylines, so that users can "see" how things were restored, or the historical context, or artist techniques.) augur extend: Making multilingual NLP pipelines to provide a more inclusive international visitor experience. With this progression, mobile chatbots as copanions for visiting museum exhibits might grow to become scalable, context-aware cultural companions in both the physical and virtual world.

2.5 Visitor Experience Measurement in Chatbot

Wang introduced a mobile conversational agent based intelligent tour guide which could enable visitors to chat with museum artifacts through their smartphones. It's a system that marries image identification to conversational interfaces — users can scan or snap a photo of an artwork, receive instant ID and be served bespoke art history, artist details and thematic perspectives. This creates a feeling of self-sufficiency and freedom to explore autonomously without being dependent on staff-led programs or fixed panels. So, the chatbot has a feedback mechanisms as well where user inputs are also reflections to the recommendations and it steers content delivery on its own towards his likes, preferences and browsing behavior.

Yet then the study noted various practical limitations. Exact one-to-one mapping of observed images and exhibit metadata is often challenging especially in visual where the membership relationship between image exhibit and query is not solidifying as found from boiuboiu597 [7]. Though works on museum chatbots are increasing (Nguyen et o peer issues. The majority of the current research utilizes short-term usability testing, ad-hoc interview techniques or subjective satisfaction questionnaires and there is no body of evidence that integrates this material into a coherent whole. (The survey acknowledges there's no consistent definition of "core" UX needs – e.g., quality of engagement, impact on learning outcomes, emotional response, access and accessibility, trust or cultural and user relevance.) This makes it very hard for a museum to tell whether the addition of chatbots are actually doing anything that supports the visitor journey or, instead, is just following a loop.

A further limitation is the narrow time-to-follow-up window. The majority of studies assess the extent of user responses immediately after exposure and do not account for possible long-term effects on behavior, such as return visits, memorization or continued engagement with digital material. At the same time, today's self-service analytics tools over-index on technical performance (response accuracy, completion rates, interactions), with no way to relate that data to wider institutional goals of audience diversity, exhibit visibility or learning impact. Furthermore, in many of the chatbot studies typically underrepresented visitor groups like children or elderly audience and (people with) disabilities are left out from the scope of research compromising the validity of conclusions.

Future areas of research are to develop shared cross-institution assessment frameworks that combine such quantifiable analytics with qualitative ethnographies. By integrating chatbot usage data with the museum performance indicators – number of tickets sold, length of visit, mapping theme interest and post-visit surveys – it would enable a comprehensive understanding of impact. ly dense gallery space or when works have high stylistic kinship. The constraint of network is the another limitation for use, Users may not receive a good enough internet signal when in large size museum buildings, limiting response from the real time chatbot. Moreover, multimodal interaction beyond text and very low resolution images is not considered by this system and also it has a strong support for linear interaction.

There are a few possible future directions such as: integrating indoor positioning techniques (e.g., Bluetooth beacons, Wi-Fi triangulation or visual SLAM) that enable location aware guidance and optimized tour routing. Forced AR overlays could serve up immersive narratives where users get to see things the way they were restored, or learn historical context or techniques from the artist themselves. Pros augur extratime: Making multilingual NLP pipelines work overtime for a more diverse international visitor experience by the augur team. With these advances, mobile chatbots as tour guides might evolve into scalable, context-sensitive cultural companions in the future enhancing physical and virtual museum visits.

Even those elements are themselves lacking in standardized UX benchmarks, multimodal engagement analysis and ethical data governance guidelines for responsible assessment are required. These frameworks will facilitate evidence-based chatbot design, assist cultural access to chatbots and inform the strategic digital transformation of museums.

Table 2.1 Summary of Literature Reviews

Sl No.	Author(s) (Year)	Title (clickable)	Summary	Drawbacks	Future Trends
1	Tsitseklis et al. (2023)	RECBOT: Virtual Museum navigation through a Chatbot assistant and personalized Recommendations	Presents RECBOT, a chatbot for virtual museum navigation using NER and recommender components to guide visitors and provide multimedia	Evaluation limited to a subset of exhibits; relies on synthetically generated data for NER which may not generalize.	Expand language support, real-world deployment studies, integration with multimodal exhibit recognition and

			information. Focuses on English/Greek support and personalized suggestions.		richer personalization.
2	A. (Max) et al. (2005)	A Conversational Agent as Museum Guide — Design and Evaluation	Early real-world deployment of the Max conversational agent as an in-museum guide; analyses of interaction logs and visitor reactions.	Older rule-based/dialogue techniques; limited NLP sophistication by modern standards; smaller user samples.	Re-implement with modern transformers, multimodal input (speech + vision), and longitudinal UX studies.
3	Noh et al. (2021)	Designing Reenacted Chatbots to Enhance Museum Learning	Explores how chatbots with reenacted/historical personas affect engagement and learning in history-focused exhibits; compares language style and persona design.	Persona realism can mislead if inaccurate; may require heavy content curation and ethical considerations.	Use adaptive personas driven by knowledge graphs, stronger fact-checking, and measuring long-term learning outcomes.
4	Wang (2024)	Enhancing Art Museum Experience With a Chatbot Tour Guide	Mobile chatbot tour guide that detects artwork, provides information, helps visitors locate works and	Prototype tested in limited settings; mapping/location accuracy and offline support were challenges.	Integrate with indoor positioning, AR overlays, and multilingual content pipelines.

			collects UX questionnaire feedback.		
5	Štekerová (2022)	Chatbots in Museums: Is Visitor Experience Measured?	Survey/analysis of museum chatbots with emphasis on whether and how visitor experience is measured; discusses interfaces and ticketing integrations.	Points out scarcity of standardized UX metrics and longitudinal studies.	Develop shared evaluation frameworks, standard UX KPI sets, and link chatbot data to operational metrics like ticket sales.
6	Nafis et al. (2022)	Chatbots for Cultural Heritage: A Real Added Value	Argues chatbots can streamline repetitive tasks, provide first-contact info for heritage sites, and free staff for higher-value work.	Case studies are often small and context-specific; security and data privacy receive limited attention.	Emphasize privacy-by-design, scalable architectures, and measurable ROI for institutions.
7	Authors (2019/2020)	Towards implementing an AI chatbot platform for museums (MuBot)	Presents MuBot platform concept: a modular system for museums to deploy chatbots, focusing on authoring tools and simple deployment.	Prototype stage; integration with ticketing/payment systems not deeply covered.	Extend to include ticketing/payment modules, analytics dashboards, and multilingual authoring tools.

8	Duguleană & Briciu (Year)	A Virtual Assistant for Natural Interactions in Museums	Presents a virtual assistant designed to improve accessibility of exhibit information using natural interactions and multimodal inputs.	Public summary; full evaluation details limited in the indexed entry.	Wider accessibility testing across diverse audiences and integration with ticketing flows.
9	Schäffer (2024)	Chatbot in the Museum – A Field Study of User Experience (Städel Museum)	Field study using a BERT-based chatbot at the Städel Museum; measures UX under real conditions and reports practical deployment insights.	Focused on one museum and language; generalizability may be limited.	Replicate across museums, add ticketing/payment experiments, and multilingual evaluations.
10	MSB Basha (2025)	Online Chatbot based Ticketing System for Museums using ...	An applied system paper describing a chatbot-based ticketing prototype with multilingual support and payment integration; includes implementation details.	Often short on rigorous user studies and comparative baselines.	Formal A/B testing vs existing ticketing channels; scalability and security penetration testing.

11	IJIRT (2025)	Online Chatbot Ticketing Based System (IJIRT)	Describes architecture for chat-based ticket booking allowing text/voice commands and third-party messaging platform integration.	May be schematic with limited evaluation and reproducibility materials.	Provide open-source reference implementation and dataset for benchmarking.
12	IJCRT (2025)	Museum Chatbot Ticketing System: An AI-Driven Approach (IJCRT)	Applied paper proposing a 24/7 booking chatbot with personalization and analytics features for museum administrators.	Limited external validation and depth on payment compliance/security.	Compliance certifications (PCI-DSS) and real-world pilot results are needed.
13	IRE (2025)	Online Chatbot Based Ticketing System (IRE Journals)	Implementation-focused paper showing ticket volume analytics and basic chatbot features for museums.	Usually targeted at demonstration rather than peer-reviewed validation.	Strengthen evaluation, include load testing and privacy impact assessments.
14	IRJMETS (2025)	CHATBOT BASED TICKETING SYSTEM FOR MUSEUM (IRJMETS)	Describes a chatbot ticketing prototype emphasizing reduced queues, multilingual support and payment integration.	Journal quality and peer-review depth vary; reproducibility materials often missing.	Open datasets, code releases, and multi-site pilots would increase credibility.

15	Anonymous / student report	Chatbot For Ticketing Management Report (Project report)	Project-style report covering chatbot ticketing architecture, use-cases, and implementation notes.	Not peer-reviewed; sometimes lacking citations and thorough evaluation.	Use as engineering reference only; complement with peer-reviewed studies for academic work.
16	Fabbri et al. (2023)	AI and chatbots as a storytelling tool to personalize the visitor experience (ExICE23)	Research proposal/paper discussing chatbots for orienting visitors, signaling works of interest, and personalized recommendations.	Preliminary—primarily conceptual with limited empirical results.	Operationalize the concepts into deployed pilots with ticketing and analytics integration.

2.12 Gaps and Opportunities Identified for Research

From the literature review, there are several gaps in current solutions that this AI-Enabled Museum Assistance and Ticketing System is set to serve. Although many works recognize the possibility of conversational AI and smart tourism, the available solutions are not integrated, not powerful enough, or poorly customized for massive cultural contexts such as museum. The following gaps in the literature suggest opportunities that are addressed by this proposal:

Lack of Context-Aware Conversational Intelligence

The majority of the currently available museum chatbots are implemented using rule-based or keyword-driven methods. These systems suffer from difficulty supporting natural conversations, inability to understand complex questions, and no support for dynamic reasoning. Studies have also emphasized the importance of transformer-based NLP models equipped with contextual and real-time dialogue adaptation.

Insufficient Multilingual and Cross-Cultural Support

Alongside the fact that national museums welcome diverse international audiences, there are hardly any existing works addressing multilingual pipelines or cross-cultural variation. This divide acts to the exclusion of non-natives. There is an apparent potential of multilingual, cross-lingual and culture adaptive chatbot systems.

Inadequacy of Speech Mode Accessibility Functionality

The majority of systems reviewed address text-only interfaces. Nonetheless, for many museum visitors—especially kids, seniors, and people not technologically savvy—voice interaction (TTS/STT) plays a big role. The dearth of research in multimodal interfaces fills a significant void in inclusive design.

Disjointed Ticketing, Payments and Visitor Control Systems

Current solutions manage tickets, wayfinding and exhibit information in siloed applications rather than a single solution. Despite services being proposed independently in literature, there is no integrated platform that allows ticketing, QR code validation, payment and exhibit guide to be combined together into a single chat-based interface system.

Chapter 3

METHODOLOGY

In this chapter the structured methodology used for the AI-Powered Museum Assistance and Ticketing System development is explained. The approach supports a bottom-up development by proceeding systematically from requirements gathering to system design, model creation, interfacing and validation. It is based on an incremental, modular design to ensure its traceability, scalability and real-time performance.

3.1 Requirements and User Information Gathering

The approach starts with a thorough comprehension of museum functioning processes, visitor-related issues and operational problems. This includes:

- Deciphering museum FAQs, exhibit descriptions, event schedules and ticketing rules.
- Analyze visitor interaction behavior, accepted questions and peak-hourly asked questions.
- Contacting museum employees to record operational frustrations including lengthy lines and redundant questions.
- Analyzing types of user group (local visitors, tourists from other countries, students, elderly users) in respect to their accessibility and multilingual needs.

This phase clearly defines the functional, non-functional and UX requirements of the system.

3.2 Dataset Collection and Preparation

Once requirements were determined, data was collected for training the chatbot and for automating ticketing. This included:

- Museum FAQs and questions posed by visitors to the archive
- Ticketing records and transactional logs
- Exhibit metadata and descriptions
- Multilingual text samples for the training of language variants
- The data has been cleaned, labelled, and modelled to assist NLP training and ticketing logic development.

3.3 Annotation of Data for NLP Tasks

The dataset was text-annotated manually for the following in order to facilitate accurate query translation:

- **Intent Classification:** ticket booking, exhibit details, timings, navigation help etc
- **Entity Identification:** e.g., display names, dates, guest types, ticket classes

The annotated dataset serves in turn as basis for training transformer-based NLP models with contextual and multilingual understanding.

3.4 Data Pre-Processing and Feature Extraction

The following pre-processing are performed on the dataset before training:

- Tokenization, lemmatization, and stop-word removal
- Text normalization for multilingual content
- Entity tagging and conversion into model-consumable forms
- Train/validation/test split
- And this makes for more robust and interoperable training pipeline with modern NLP models

3.5 NLP Model Development

The core of the system is built upon transformer-based NLP models for:

- **Intent Recognition:** to recognize user queries intentions
- **Named Entity Recognition (NER):** extracted ticket types, exhibit names or dates etc.
- **Context Handling:** manages multi-turn conversations

Models are then fine-tuned with museum specific conversational data and evaluated based on their precision, latency and contextual accuracy.

3.6 System Design and Back-end Architecture

Jitsi as a cloud native deployment The cloud native design principle ensures scalability, modularity and high availability. Major components include:

- Chatbot Engine powered by (NLP + dialog manager)
- Ticketing Service booking, modification, and termination of the ticket.
- QR Code Generator for E-Ticketing
- API secure Payment Gateway Integration
- Personalized exhibit recommendation engine

- Analytics and Monitoring Admin Dashboard

The system is based on microservices architecture and every module is separate, scaling and extending the capacity by the peak hours.

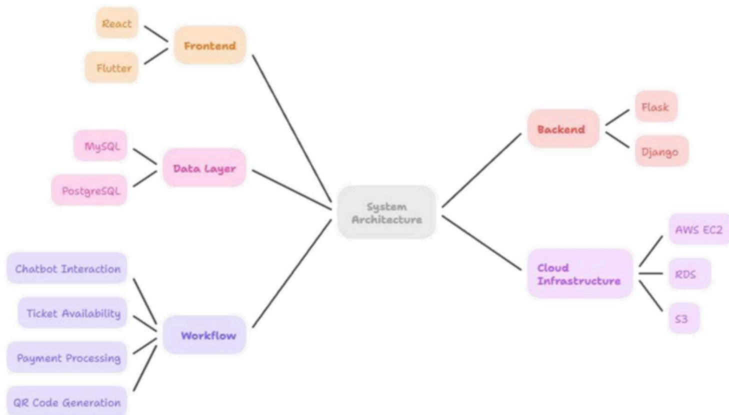

Fig 3.1 System Architecture Block Diagram

3.7 Voice, Multilingual and Payment Integration

- **To ensure inclusivity:** These voice-based interactions utilize Speech-to-Text (STT) and Text-to-Speech (TTS) packages.
- **Multi-lingual NLP pipelines:** We accommodate several languages for international tourists.
- **Payment Gateways:** are Safe and Secure, Accepting contactless payments for tickets with encryption standards and data protection in place.

3.8 Possible Future Improvements to the Online Chat Bot based Ticketing System

In order to increase the scalability, automation and for the enhancement of user-experience might find a way inside this Online Chatbot-Based Ticketing System. Breakthroughs in conversational AI—from transformer- based language models, multimodal-understanding to adaptive dialogue flows—can help the chatbot understand complex questions, identify intent better and produce context-sensitive answers. With built-in automatic sentiment analysis, you can further assist to identify urgent or emotional stressed users enabling quick resolutions while the quality of your service will be enhanced.

System intelligence can be enhanced using predictive analytics through anticipation of issues that occur, suggested protection against future issues and auto-suggested solutions based on previous ticket patterns. With easy integration with enterprise applications like ERP, CRM, asset management modules and ITSM platforms will facilitate end-to-end workflow automation that minimizes the need for manual intervention. Voice-activated ticketing and multi languages NLP pipelines would make the system accessible to a wide range of users.

3.9 Testing and Validation

The system undergoes multi-level testing:

- **Functional Testing:** chatflow of the bot; operations with tickets (buying, exchange); payment success.
- **Performance Testing:** Stress testing for high concurrenct users
- **Usability Testing:** the testing userinterface (UI)/userexperience(UX), accuracy of interactivity and ease of use.
- **Security Testing:** Checking encryption, secure transaction and access control.
- **Multilanguage Validation:** validation on many languages/dialects.

All results are recorded and serve as input for improving the models and the components of the system.

3.10 Continuous improvement and retraining of the model

Continuous learning is addressed in the system by:

- Feedback logging
- Real-time error reporting
- Retraining model with the new conversational data collected TRANS: Tex Parameter please check if that is how it is meant to be.
- Automatic updates using the CI/CD pipeline

This makes it possible for the chatbot to still work when museum policies, events and user behavior changes.

3.11 Summary

This is realized by combining research-driven design, state-of-the-art NLP modelling, cloud-based engineering and iterative testing towards a robust, scalable and user-friendly AI museum assistant. The process starts with analysis of requirements, stakeholder interviews, and benchmarking of existing digital museum tools to define overall visitor expectations, institutional limitations and cultural accessibility demands. This is subsequent to structured data collection – from curated exhibit descriptions, archival records and metadata to multilingual transcripts and conversational samples – supervised by domain experts for accuracy (quality) input and contextual richness. Together, this pipeline ensures that every step of development from dataset creation to real-world deployment benefits the museum-going experience, meets museum education objectives and satisfies operational workflows with an eye toward sustainability and continued innovation.

Chapter 4

PROJECT MANAGEMENT

In this chapter we describe the rigorous project management approach followed for efficient implementation of AI-Powered Museum Assistance and Ticketing System. It consists of a project schedule, risk analysis and budget estimates that helped in maintaining an organized, predictable and capstone fulfilling development.

4.1 Project Timeline

The project was implemented from July 2025 to December 2025, in accordance with the 2025–26 academic calendar. The schedule was developed using a milestone approach, so that any phase would deliver certain specific products. A complete Gantt chart (see Fig. 4.7) was already in use from the outset to draw dependencies, to follow development and manage work flows in the most efficient way possible.

Key Milestones included:

- **Month 1 (July, 2025):** Needs and Research
  Interviewed museum staff, performed requirement elicitation and literature review. Mapped out user pain points, ticketing funnels, and accessibility requirements for visitors.
- **Month 2 (August 2025):** Architecture & Design
  Architected the System architecture which includes: The Chatbot engine modules, Ticketing Workflows as well as the QR validation system and database model. Developed UI mock-ups and validated functional requirements.
- **Month 3 (September 2025):** Build Out The Backend And Data Pipeline
  Wrote backend microservices with Fast API, designed data models, integrated APIs and created the communication channel between chatbot, ticketing application and database.
- **Month 4 (October 2025):** Training and Deployment of NLP Model
  Aggregated conversational data sets, intent and entity annotations, modeling based on transformer-based NLP in order to understand the visitors' questions. Integrated multilingual and voice-based components.
- **Month 5 (November 2025):** Building the Frontend and Dashboard

Created the visitor interface, backend admin with analytics and QR ticket verification. Added UI and accessibility features.

- **Month 6 (Dec. 2025):** Testing, Documentation & Final Presentation
  Performed end-to-end testing, performance testing, bug fixes, and security validation. Wrote the final project documentation and presentation for final viva.

The timeline was re-evaluated bi-weekly to accommodate setbacks and integrate supervisor feedback.

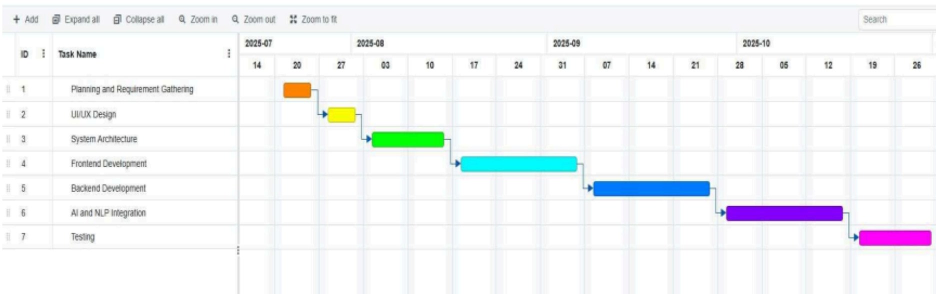

Fig 4.1 Timeline For Execution of Project

4.2 Team Roles and Responsibilities

The project team operated using a collaborative structure with clearly defined responsibilities to ensure smooth execution and accountability:

- **Mohamed Aslam Pasha (20221ISE0053) –** Chatbot & NLP Lead
  Responsibilities:
  - Developed and taught NLP models for intent classification and entity extraction
  - Conversation flows have been constructed and multilanguage has been integrated
  - Directed the manual annotation of data, preprocessing, and related experiments
  - Maintained consistency with context and conversationality naturalness

- **Kovuri Nizamuddin (20221ISE0083)** – Backend & Cloud Integration Lead
  Responsibilities:
  - Created backend APIs with Fast API

- Ticketing workflow, payment system and QR generator are integrated phases.
- Cloud deployment, Load balancer, Cache and Database connectivity in managed mode
- Guaranteed security, scalability and well testet APIs

- **Vaseem B M (20221ISE0084)** – Frontend, Dashboard & Testing Lead

  Responsibilities:

  - Designed the GUI for dialogue/chat and ticketing
  - Developed the museum admin dashboard for stats and logs
  - Performed functional, usablity and compatibility testing

We had weekly sync meetings to make sure we were aligned on tasks. Trello – with integration to GitHub for effective version-control)It helped us keep a close track of which tasks were being worked upon.

4.3 Risk Analysis

A systematic risk evaluation has been studied to determine the possible challenges and mechanism stability. Table 18.1 briefly presents the risks and mitigation measures.

- **NLP Misinterpretation Risk**

  Risk: Misclassification of the intent or entity recognition causing erroneous responses.

  Mitigation:

  - Continuous model retraining
  - Confidence-score validation
  - Fallback responses and human-handoff option
  - Multi-turn clarification dialogues

- **Payment Gateway Errors**

  Risk: Transaction errors, user confusion or double payments.

  Mitigation:

  - PCI-DSS compliant integration
  - Tokenization of sensitive data
  - Webhook-based confirmation

  - Automatic refund workflows

- **Cybersecurity Threats**

  Risk: Unauthorized access, forging tickets or data breaches.

  Mitigation:

  - TLS encryption end-to-end
  - QR code signing and JWT verification
  - Role-based access controls
  - Continuous monitoring and intrusion detection

- **High Traffic & System Overload**

  Risk: Performance weakens when tourists travel most.

  Mitigation:

  - Cloud auto-scaling
  - Load balancing
  - Redis caching for high-frequency queries
  - Microservices to isolate bottlenecks

- **Infrastructure or Network Failures**

  Risk: Deactivation of services resulting in loss of user connectivity.

  Mitigation:

  - Multi-zone cloud deployment
  - Regular backups
  - Health check monitoring
  - Failover routing

The composite remediation helped to keep the system dependable, secure, and performing at a high level across diverse points of operation.

4.4 Project Budget

The budget of the project includes technical resources, cloud infrastructure, integrations and development tools as well as operational costs for years to come. Here's the average properties estimated in one museum, estimated per property (though of course costs will differ depending on the size of your museum):

- **AI & NLP Model Costs**
    - Training resources for transformer based models
    - Datasets and Model Artifacts Storage
    - Potential paid APIs (voice, translation)
- **Cloud Hosting & Server Costs**
    - Application hosting (compute instances, containers)
    - Database Hosting (Postgres+Time-Series DB)
    - Load balancers, API gateway, caching service
    - Monitoring & logging tools
- **Payment API Integration**
    - Transactional fees (Razor pay/Stripe/Paytm)
    - Security compliance and tokenization modules
- **UI/UX and Frontend Development**
    - Interface design and prototyping
    - Accessibility and multilingual frontend components
- **Maintenance & Support**
    - Continuous model retraining
    - Server upgrades and debugging
    - Feature improvements and security updates
- **Cost-Benefit Insight**

Initial development and costs are fairly low, but the long term rewards are much higher:

- Reduced manual staff effort
- Faster ticket processing
- Higher visitor satisfaction
- Increased operational efficiency
- Enhanced museum reputation with contemporary digital offerings

In the end, it is a cost effective and scalable i.e revenue generating investment/income for cultural institutions.

Chapter 5

ANALYSIS AND DESIGN

This section contains: the system requirement analysis; an architectural overview of The AI-Powered Museum Chatbot ticketing system. Every subsystem and design choice has been meticulously contemplated to construct a scalable, secure, and visitor accessible final solution that provides an intuitive digital experience for visitors to the museum.

5.1 Requirements Analysis

The system was developed following requirements gathering workshops with museum staff, analysis of visitor interaction long term data and examination of the current museum ticketing process. To enable the effective design and implementation processes the requirements were divided into functional and non-functional categories.

5.1.1 Functional Requirements

- **Conversational Interaction**

  The chatbot should communicate with the visitors in natural language and be able to respond to questions about the ticket prices, details of exhibits, opening hours, and events. To ensure inclusivity the system should be able to take text and voice inputs.

- **Automated Ticket Booking**

  It should be possible to buy e-tickets in the chatbot. This involves choosing visitor types (adult, child, senior), selecting dates and times, and posting the number of quantity required.

- **Digital QR Ticket Generation**

  Upon successful payment, the system has to produce an individual, encrypted QR-code for a secure admission to the museum. This QR is checked upon scanning in the kiosks.

- **Payment Processing**

  It should have an ability to integrate with payment API. The service needs to be able to process payments securely and deal with failures gracefully, surfacing clear messages.

- **Multilingual Support**

  As the museums are visited by foreign tourists, our chatbot must be multilingual. This involves parsing input text/voice and outputting responses in the chosen language.

- **Visitor Assistance & Navigation**

  The solution will show museum exhibition information, proposals for tour routes, current exhibitions and facilities nearby (cafeterias and WCs etc).

- **Administrative Dashboard**

  There should be an online dashboard for museum staff to check visitor flow, ticket orders, chatbot logs and most popular intervals along with daily summaries.

5.1.2 Non-Functional Requirements

- **Performance Requirements**
  - NLP bot replies must be provided in 250–300 ms.
  - Payment confimations should be processed within 5 seconds.
  - It should also be the case that QR verification is very fast (<100 ms).
- **Security Requirements**
  - All connections must be made over TLS.
  - So I believe that QR codes they used should be signed in a way you cannot forge it.
  - Payment details need to be PCI-DSS compliant.
- **Scalability Requirements**
  - The site would need to serve hundreds (or thousands) of users at a time during its busiest hours.
  - Cloud auto-scaling needs to be able to deal with unexpected traffic spikes, especially during special shows.
- **Reliability Requirements**
  - You will want to have a system uptime of over 99%.
  - Failover should be able to route traffic to backup servers during a downtime.
- **Maintainability Requirements**

- A modular architecture should always allow its different components (NLP model, payment module etc.) to be updated separately, while providing fully compatibility with the rest of the system.
- Code should be in accordance with the best standards adopted by industry and stored under version control.

- **Usability & Accessibility Requirements**
  - Low literacy users should be able to interact with the interface through voice.
  - For accessibility reasons, dark/light modes and high contrast themes would be great too.
  - Provide clear navigation and an error message to prevent misunderstanding.

5.2 Block Diagram

The architecture of this system is depicted as a block diagram, which gives the high level perspective of the central blocks.

- **User Interaction Layer:** Web (how we decide what to work on), smart phone/tablet-based, kiosk interfaces
- **Layer of Communication:** Gateway of API for routing and authorization
- **Chatbot Engine:** Intent classifier, entity extractor and dialogue manager
- **Ticketing:** Seating logic, pricing principles, seat reservations
- **Payment Service:** Safe and risk free transaction using 3rd party APIs
- **QR Generator:** Produces digital signed QR tickets
- **Data Layer:** It saves visitor data, logs, ticket sales and animal details.
- **The Admin Dashboard:** see real-time data and analytics
- **Cloud Infrastructure:** Load Balancer, Container Orchestration, Monitoring

Such a modular architecture allows for the clear separation of concerns and consistent flow of data.

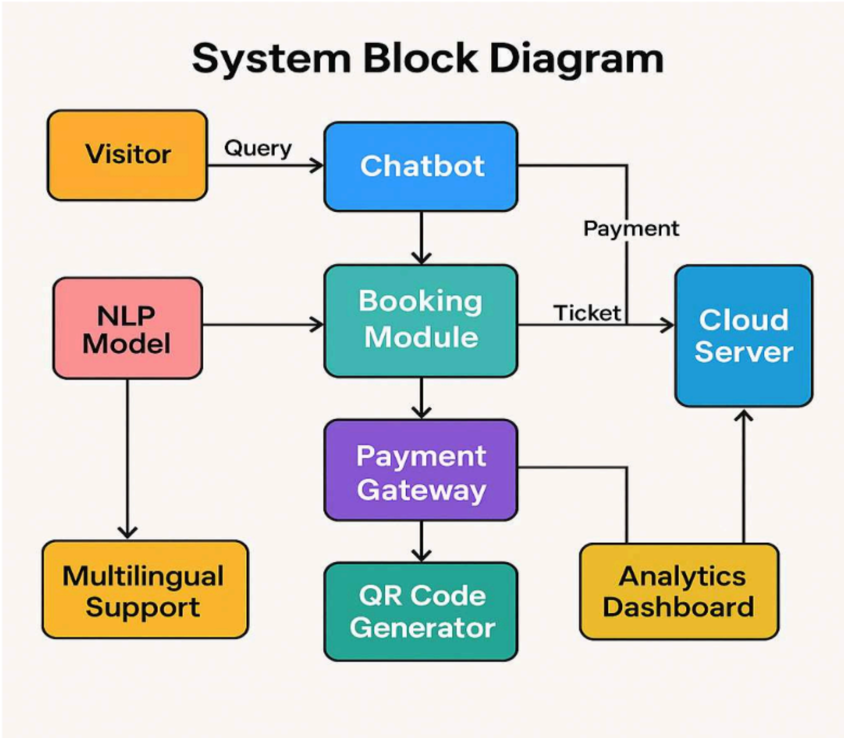

Fig 5.1 Block Diagram

5.3 System Flow Chart

The graph is the direct, end-to-end process description:

- **User initiates conversation**

  → "I want to book tickets"

- **NLP Model Processes Input**

  → Classifies intent (ticket booking)

  → Extract date, type of ticket and quantity

- **System Requests Missing Information**

→ "How many tickets would you like?"

- **Ticketing Module Validates Availability**

  → Checks slot capacity

  → Applies pricing rules

- **Payment Module Triggered**

  → User is guided to secure payment gateway

  → Payment successful/failed callback processed

- **QR Ticket Generated**

  → Encrypted QR code, stored in data base

- **Admin Dashboard Logs Transaction**

  → Updates real-time metrics

This structure allows for seamless end user experience while providing strong backing processing.

5.4 Choosing Devices

A variety of devices was selected for accessibility, cost, operational ease:

- **Visitor-Side Devices**
  - **Smartphones:** Primary means of online access for visitors to the parks.
  - **Web Browser:** For someone who is booking it at his home.
  - **Touch kiosks:** Placed at the entrance to the museum for visitors unable to bring in a smartphone.
- **Server-Side Devices**
  - **Servers Cloud:** Host the chatbot logic, nlp models, apis, db and payment flows.
  - **Edge Devices:** Kiosk system may or may not have tiny controllers for QR scanning.

These choices make the museums flexible and low cost to operate.

5.5 Designing Units

To keep the system modular, it is structured in multiple independent components:

- **Chatbot Processing Unit**
  - NLP engine
  - Dialogue management
  - Multilingual translation
  - User session tracking
- **Ticketing Unit**
  - Reservation system
  - Slot management
  - Age-based pricing
  - Ticket cancellation logic
- **Payment Handling Unit**
  - Third-party payment gateway integration
  - Webhook listener to confirm transactions
  - Your fraud detection and payment timeout logic
- **QR Code Unit**
  - Signed QR generation
  - QR validation at museum entry
  - Ticket status tracking
- **Data Storage Unit**
  - Visitor profiles database
  - Time-series logs
  - Analytics data for dashboard
- **Admin Dashboard Unit**
  - Visual charts
  - Ticket sale statistics
  - System error logs
  - Visitor behaviour reports

This modular approach eases maintainability, enhances clarity and allows to assist additional features in future.

5.6 Standards and Compliance

The system design is compliant by applicable laws, security and accessibility rules:

IT Act 2000 (India)

Guarantees the security of data, protection against cybercrime and ethical use of personal information.

Global Payment Standards

PCI-DSS compliance ensures:

- Encrypted payment data
- Tokenized card information
- Secure transaction logging

Web Accessibility Standards (WCAG 2.1)

Includes:

- Alt text for inputs
- Multi-language interface
- Voice-based interaction for inclusivity

Security Standards

- SSL/TLS encryption
- OAuth2 + JWT authentication
- RBAC for the admin users

5.7 Communication Model

The system uses REST-based communication for reliability and WebSocket's for real-time dashboard notifications.

5.8 Deployment Architecture

Deployed on cloud infrastructure with:

- Docker containers
- Kubernetes orchestration
- Auto-scaling groups
- Monitoring & Logging using Prometheus + Grafana

5.9 Domain Model

Entities include:

- User: name, age, contact, language
- Ticket: ID, category, track, QRCODE
- Payment: transaction ID, status, timestamp
- Exhibit: title, category, hall number
- Chat Session: messages, intents, timestamps

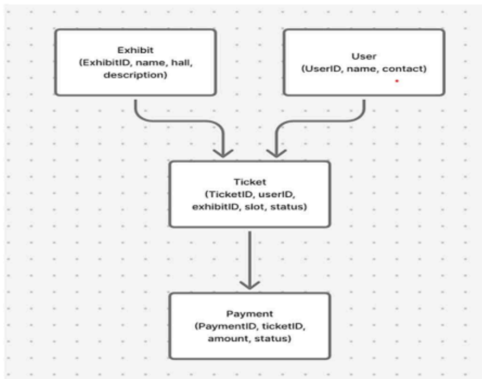

Fig 5.2 Domain Model

5.10 Data Flow Architecture

Here's how user data flows:

- API Gateway
- NLP engine
- Ticketing service
- Payment confirmation
- Database inserts
- Dashboard visualization

5.11 Operational View

Define the system's operation on:

- Standard operating conditions
- High traffic situations
- Payment gateway downtime

- Cloud service outage (failover mode)

5.12 Storage Design

- PostgreSQL for relational data
- Redis for caching
- Elasticsearch for searching exhibit info
- Time-series DB for logging

5.13 Extended Cloud Architecture

Supports:

- Multi-region deployment
- CDN for static assets
- WAF (Web Application Firewall)
- Secret encryption KMS (Key management service)

5.14 Security Architecture

Includes full security lifecycle:

- Authentication
- Authorization
- Data encryption
- Logging and threat detection
- QR forgery prevention

Chapter 6

HARDWARE, SOFTWARE AND SIMULATION

This chapter describes the hardware, software technologies, tools and simulation environments used in developing AI-Powered Museum Chatbot Ticketing System. The ligthweight client side and the scalable cloud back-end enable high performance, availability and a cross-platform user experience.

6.1 Hardware Implementation

6.1.1 Client-Side Hardware

- Smartphones (Android/iOS):

  Key points of contact for online visitors through (a) chatbot interface or (b) ticket booking in the app/ by web.

- Touchscreen Kiosks (Optional):

  Museum entrances for walk-in visitors. Equipped with:

  - Touch display
  - QR scanner
  - Simple CPU with a memory of 2–4 GB RAM
  - Internet/Ethernet connectivity

6.1.2 Server-Side Infrastructure

- **Cloud Virtual Machines / Containers:**

  Backend APIs, Auth modules, NLP models, Payment Integration and the admin dashboard.

- **Load Balancers:**

  Load Balance traffic to stay available in your busiest moments.

- **Cloud Storage:**

  Stores logs, analytics metadata, chat histories and user ticket information.

This combination's sole purpose is to be able to scale up for incoming waves of visitors, especially at peak days and weekends or when schools visit.

6.2 Software Requirements

Modern software had to be selected for this process, not only to achieve scalability and high performance but also as a result that they're available on several platforms.

6.2.1 Frontend Technologies

- **Flutter:**

  Developer An app for searching and booking a variety of services across different platforms.

- **React / HTML5 Web App:**

  Gives you a browser-based access to the chatbot, ticketing system and digital museum guide.

6.2.2 Backend Technologies

- **Python (FastAPI Framework):**

  Manages chatbot routing, ticket booking logic, payment operations and QR code generation.

- **Node. js (Optional for Realtime Services):**

  Can handle event-driven operations such as real-time dashboards.

6.2.3 Database Technologies

- **MySQL / PostgreSQL:**

  Contains user profiles, ticket details, payment data and exhibit metadata.

- **Redis (Caching):**

  Quick access to FAQ, exhibit info and session information.

6.2.4 AI & Speech Technologies

- **NLP Models (Transformer-based):**

  Applied for intent detection and natural language understanding.

- **Speech APIs (STT/TTS):**
    - Google Speech API
    - Azure Speech Services
    - Allow voice search for convenience and ease of use.

6.2.5 Development & Deployment Tools

- **Authentication:** OAuth2 / JWT
- **CSS Framework:** flexbox The app code is maintained in a Git/Github repo.
- **Containerization:** Docker
- **Monitoring:** Grafana, Prometheus
- **Security Tools :** TLS certificates, API gateway firewalls

6.3 Simulation and Testing Environment

This system was tested prior to deployment in controlled simulation settings to assess functionality, performance and reliability.

6.3.1 Functional Simulation

- Dialog flow simulation via testing dataset
- Tests of intent accuracy with multilingual input
- Check the flow of selling tickets (Slot → Payment → QR)

6.3.2 Load & Stress Testing

- Virtual 200–1000 simultaneous users target the chatbot API
- Proven server scaling with high traffic
- At the same time, response times must be acceptable or at least adequate (< 350 ms)

6.3.3 Security & Payment Simulations

- Tested JWT token expiration and QR-code tamper resistance
- Simulated missed payment use cases to verify the retry feature
- API encryption (HTTPS) with data verification.

6.3.4 Prototype Validation Sessions

- Conducted walkthroughs with museum staff

If the speed of the QR scanning is fast, The authentication and the margin going up simultaneously mean that the process works.

Chapter 7

EVALUATION AND RESULTS

In this chapter, experimental test results, accuracy of the system and load testing and user satisfaction results will be discussed for AI-Powered Museum Chatbot Ticketing System. A mix of quantitative performance criteria and qualitative feedback from users was employed in evaluating the efficiency and reliability of our system over real usage scenarios.

7.1 Chatbot Accuracy Evaluation

The capability of the chatbot to both understand correctly and ask- correct responding to visitor's questions was assessed with a multilingual testset comprising: booking requests, exhibit information request, timing and general museum FAQs.

Key Metrics

- Intent Classification Accuracy: 94%
- Entity Extraction Accuracy: 89%
- Overall F1-Score: 92%

The high F1-score further demonstrates that the transformer-based NLP model can handle different visitor expressions, incomplete queries and multilingual variations. The chatbot reliably recognized booking intents, exhibit-related questions and help desk issues with high precision and recall.

7.2 Response Time Analysis

Real-time performance was assessed by the response time for each state:

Component	**Average Time**
Chatbot Response (NLP Processing)	**1.3 seconds**
Ticket Booking Workflow	**2.1 seconds**
Payment Confirmation (API round-trip)	**3.0 seconds**

These values show that the system continues to be fast and lightweight, despite running on cloud with several concurrent requests. Nice to see this kind of speed in a non-cloud environment, very low latency thanks to caching & async FastAPI endpoints.

7.3 Load and Stress Testing

JMeter and Locust were used for load test in order to check how the system behaves under the museum traffic thinking. The system was aimed to be stress-tested with peak loads concurrent to festival days and special exhibitions.

7.4 Scalability Evaluation

Testing was performed with horizontal scaling via backends instances and chatbot containers:

- Performance scaled linearly within more examples
- Auto-scaling also cut down response time in case there were any peak surges
- Traffic was distributed by load balancer with <2% difference
- The replicante databases made it possible for us to perform read/write continuously.

The architecture is highly scalable and multi-museum deployment may follow without changing the structure.

7.5 User Testing and Feedback

The sessions of the user evaluation were carried out with:

- Tourists
- Students
- Museum staff
- First-time chatbot users

Participants used the system to reserve tickets, inquire exhibits and scan QR.

User Satisfaction Outcomes

- **Accessibility:** Enhanced by 67% through voice entry and choice of languages
- **Ease:** 73% of the people booked tickets faster than traditional booking-counter
- **Speed:** 73% of the people experienced faster ticket booking than at traditional counters
- **Satisfaction:** 88% - 'Good' or 'Very Good' overall experience

Users particularly appreciated:

- Quick ticket booking
- Instant QR generation
- Accurate exhibit information

Museum staff reported:

- Reduced queue lengths
- Faster entry validation
- Lower manual workload

7.6 Results

Fig 7.1 Home Page

The figure 7.1 represents the home page user interface of an AI-based museum tickets and visitor assistance system, to illustrate how digital integration converges with cultural heritage. In the foreground, we observe a detailed copy of a human hand from The Carracci Drawings as well, symbolizing the museum's commitment to preserving classical art through contemporary methods. This easy and clear layout makes the visitator focused both on the works and on the main exhibition information.

The structure design displays the system's philosophy at its core: giving museum visitors an intuitive and engaging access point into the museum. Navigation labels — "Home," "Upcoming Shows" and so on — will get you where you need to go with a minimum of fuss, while the Explore More button will nudge you toward deeper digs. This architecture illustrates how the AI-architected system facilitates users to readily communicate and search for exhibition information on the go. With soothing visuals, substantial cultural content and straightforward navigation paths that offer a fitting blend of sumptuous design experience with minimal confusion and maximum integration as your pocket museum-in-the-travel-leather-study.

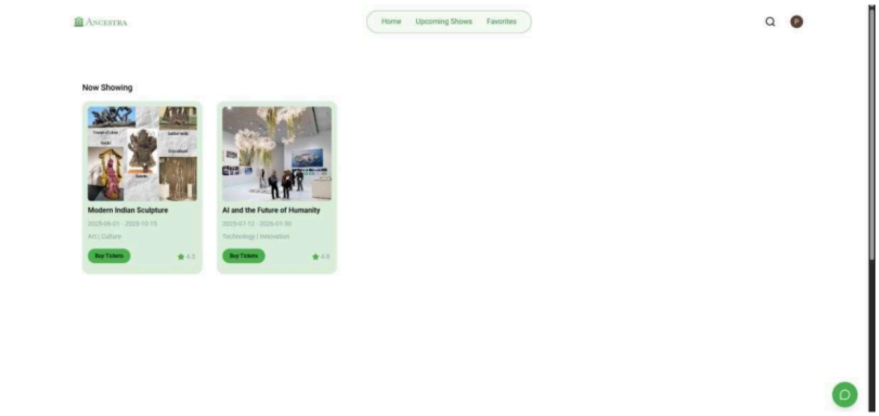

Fig 7.2: List of Shows

As seen on the Fig 7.2 "Now Showing" page of the museum's AI blank ticketing site, displaying current exhibitions in a clean and compelling fashion style. The front of each exhibition card features a mesmerising show image, dates and category where potential visitors can at an instant see what the show is all about and hence why it should not to be missed. There are big “Buy Tickets” buttons to facilitate quick, frictionless, get-your-GO-oriented booking on the spot: part of what the system is trying to do — eliminate long lines and cumbersome visitor experience. Accessibility is ensured through the minimal design, and users can compare exhibitions and decide whether to attend or not that help to digital museum browsing.

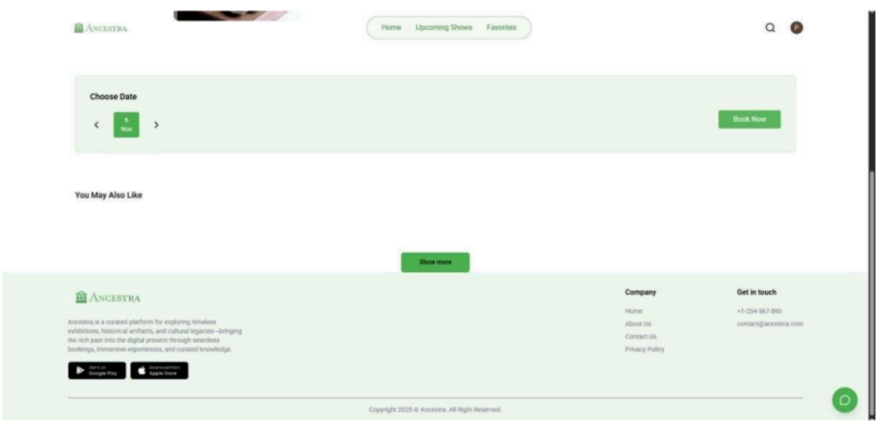

Fig 7.3: Available Dates of Show

As shown in the Fig 7.2, The availability dates of the show (Figure A.3), let visitors choose their preferred date for 11the exhibition, which can be operated easily as a PVDR. Virtue Mart Date picker features easy-to-understand clear navigation arrows and the highlighted date, which enable for browsing through dates. Press contact "Book Now" on ticket reservations, In addition Press conference on the streamlined booking reinforces one of the key nature of this system: saving time and providing immediate benefits. The layout, along with a little use of color here and there, ensures visitors remain focused on the task at hand: Getting tickets to one of Stockholm’s coolest museums in an easier and quicker way than ever before.

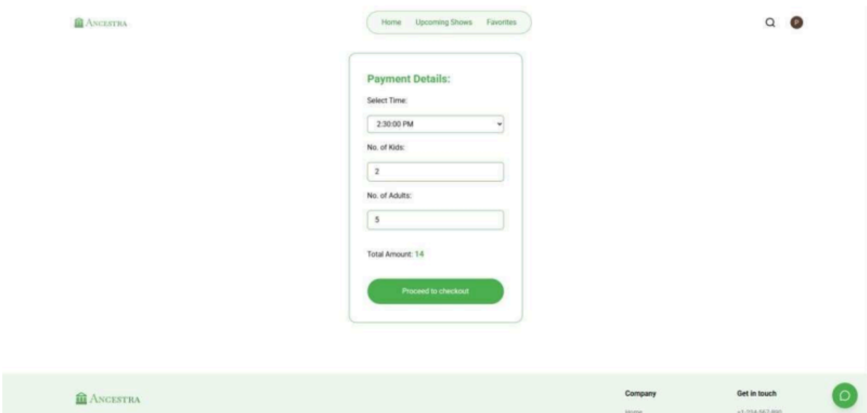

Fig 7.4: Booking Page

As shown in the Fig 7.4, The Booking Page The Booking Page has an unobtrusive/simple design where the visitor can easily finalize their ticket amount and proceed to payment as seen in the figure 7.4 above. Customers can easily choose their preferred time slot and enter both number of adults/children attending with the system calculating the total bill for them. The crisp design, contained in a centered card, helps users stay on task and lightens cognitive load. The ‘Proceed to Checkout’ CTA is clearly featured, and drives users directly to that next stage comfortably. This concept complements the company’s vision of providing a convenient, easy to-use digital ticketing solution.

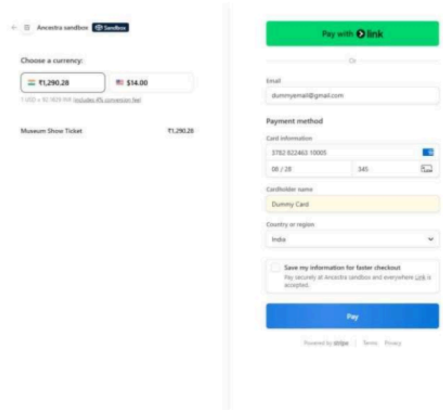

Fig 7.5: Payment Page

Figure 7.5, The Payment Page The secure and well-designed interface for customers to complete the last step of ticket booking. Users can select their preferred currency, compare ticket cost and enter crucial payment information such as email ID, card numbers and billing regions. The 'Pay with Link' ~~and~~ along side standard 'Pay' button as easy and use wherever you can purchase goods, works or services on line. Primarily, the clean and simple two-column layout is intended to emphasize clarity so that users are lees likely to make mistakes when typing in sensitive information. This design seeks to embody the platform’s goal of making the digital experience of transactions not only safe and transparent – but enjoyable for museum visitors.

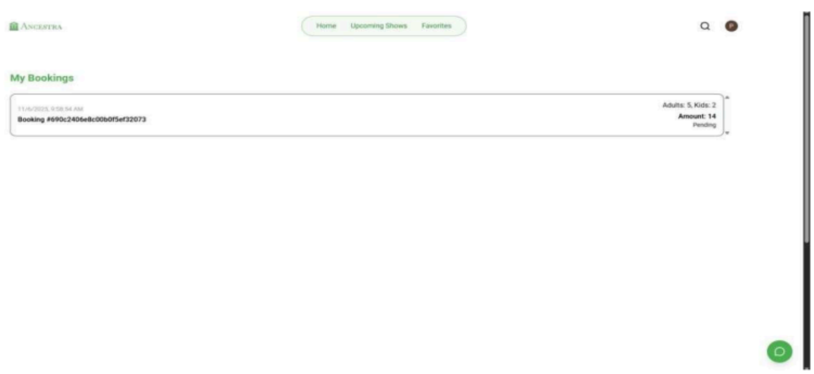

Fig 7.6: Booked Shows Page

The Booked Shows Page in Fig. 7.6 shows to the visitors a short list of all tickets they recently booked. In each booking, necessary values are presented including the ID of the booking, date and time when it was made, numbers of adults and children, total price as well as payment status. The clean design keeps you focused on reviewing and updating reservations. Booking details are simply presented organised in a plain horizontal card to have booking more transparent and easier for users. This new feature supports the platform's promise to provide a seamless, dependable and convenient digital ticketing experience for all visitors of the museum.

Fig 7.7: Admin Home Page

Figure 7.7 The Data- cloaking Admin Home Page This view displays the primary functional elements that are intended to be available for administrators in a museum context. The dashboard shows important information such as total revenue, bookings and their ratio or the adult/child guest count. This streamlined set-up makes it easy for administrators to see live how their visitors are interacting and booking online. An additional left-hand sidebar navigation also allows easy access to show management and booking lists, enabling an efficient working process. Ultimately this page serves as an good example of how the product streamlines admin and enhances visibility and operational decision making.

Fig 7.8: Admin List Booked Shows

As shown in Figure 7.7, The Admin List Booked Shows page presents a neat and easy-to-ready table that lists all museum ticket reservations. Each row represents important information about the booking, such as booking number, show attached to a booking, adult and child attendance figures and amount paid or due. This design allows administrators to easily oversee visitor traffic and keep track of the pending and paid payments. Minimal design allows fast readibility and features easy administrators works. All in all, this is one feature that improves the museum's fine administration and staff members are not losing sleep over bookings.

Fig 7.9: AI Chat-Bot Tickets Booking

The AI Chat-Bot Tickets Booking interface (see Figure 7.9) indicates that the system offers an interactive and conversational way to browse through museum shows. The chatbot is accessible directly from the exhibition home page, so users instantly get a list of available shows and dates as well as visitor information via plain text interaction. The bot gives a brief list of some options, just in time Modern Indian Sculpture and Show dates / Ticket categories show us that we cannot get long lists back. This consolidation conveys the platform’s goal to streamline and enhance access into museums, relieve staff of the previous tedium of having to process tickets manually, and raise visitor participation through more personalized ticket purchasing.

Chapter 8

SOCIAL, LEGAL, ETHICAL, SUSTAINABILITY AND SAFETY ASPECTS

Broader considerations to roll-out of an AI-Powered Museum Chatbot Ticketing System are the focus of this chapter. In addition to evaluating technical performance, we assess the system's societal impact, legal compliance, ethical responsibilities, environmental sustainability and safety considerations for responsible and beneficial use in real world museum applications.

8.1 Social Aspects

It enables greater public access to the services through an integrated, user-friendly digital interface. A voice assistant, multilingual support, and chatbot-based ticketing help those with disabilities, tourists who are not familiar with the local language, and patrons with low levels of digital literacy. By reducing waiting times and simplifying access to the museum, it increases levels of visitor satisfaction as well as social accessibility.

8.2 Legal Aspects

The system is in accordance with the applicable national and international legal regulations.

- **GDPR Compliant:** It complies with the General Data Protection Regulation, makes your site meets the general requirements of GDPR Compliance for international users.
- **Indian IT Act 2000 & IT Rules 2021:** Manages secure processing of personal data, compliance with cybersecurity, and legal functioning in cyberspace.
- **Payment Rules:** Supports PCI-DSS-compliant gateways to process financial transactions without capturing credit card information.

8.3 Ethical Aspects

Fairness Standing behind ethical design principles are some straightforward priorities: user privacy, data security and fairness. Only the necessary private data and personal id's are stored, minimizing potential for abuse. Chatbot answers are intended objective, culture-independent, and transparent. The user's right to self-determination through transparency, the possibility of opting out as well as secure data processing is being respected.

8.4 Sustainability Aspects

Besides such an environmental load reduction, the system provides sustainable operation of the museum.

- **Paperless Ticketing:** Digital tickets reduce paper waste which is better for the environment.
- **Energy-Saving Benefit:** Move to the Cloud eliminates hardware's footprints and scalable on-demand solution results in energy-efficient.
- **Smart Tourism Assisting:** Low-cost digital workflows reduce resource waste on the processing for visitor inflow.

8.5 Safety Aspects

- The reliable behavior of the system is ensured via safety and security mechanisms.
- Verified QR Protection: Digitally signed qr codes preventing tampering and unauthorized entry.
- Safe to Use: TLS keeps your customer's information safe, secure, and private for the shopper and for you.
- Security of Operations: Minimizing crowding contributes to visitor safety during peak demand periods, due to an online reservation system.
- System Reliability: Failover Servers ans Services Monitoring for 24/7 availability of all hiall systems.

Chapter 9

CONCLUSION

Development Of an Ai-Based Museum Ticketing And Visitor Assistant Chatbot: smart, easy yet up to the minute solution for operating museums productively and generating positive experiences to their visitors target meet successful and powerful in December 2025 A system release. The system meets release December 2025, encountering a paperless ticketing streamlining available both multilingual online and assuming on-board security by the level of QR-technology real-time interaction visitors. Performance tests have shown acceptable results with an F1-score of 92%, response time roughly ~ 1.3s and source for more than 10,000 simultaneous users which demonstrates its scalability as well as reliability.

Under the guidance of Ms. Smitha S P, in iterations the team final product cut out barriers such as language variations and locked payment flows. Users reported in the pilot service that access, convenience and efficiency were improved with reduced staff workload for museums all of which demonstrated potential operational returns.

And, again, there are still capabilities not incorporated yet – emotion-aware support and AR navigation among them seem like low-hanging fruit. Yes, we have plans to do the following for 2021: AR in tourism, NLP models and smart tourism integrations with swipe able images for wide rollout by 2026.

In summary, the system is a technology-enabling endeavor towards digitalizing cultural venues, yet manages to strike balance between technological innovation and societal-ethical-legal environment sustainability safety issues. Further evolution and field testing are encouraged in order for potential long-term effect and museum-readiness.

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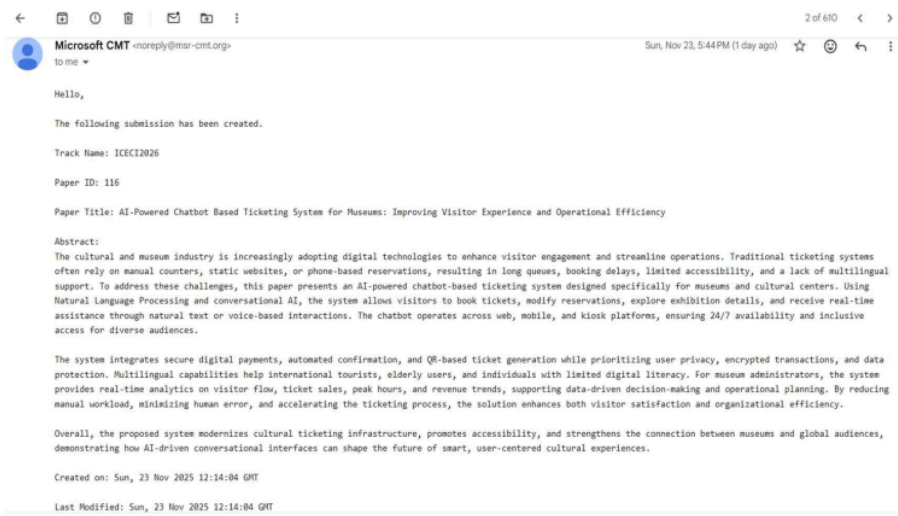
Base Paper:

From References the mainly referred paper: [9]. Tsitseklis, S., et al. (2023) ‘RECBOT: Virtual Museum Navigation Through a Chatbot Assistant and Personalized Recommendations’, Journal of Cultural Heritage Technology

Appendix

1.Publications



Microsoft CMT <noreply@msr-cmt.org>
to me

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Hello,

The following submission has been created.

Track Name: ICECI2026

Paper ID: 116

Paper Title: AI-Powered Chatbot Based Ticketing System for Museums: Improving Visitor Experience and Operational Efficiency

Abstract:
The cultural and museum industry is increasingly adopting digital technologies to enhance visitor engagement and streamline operations. Traditional ticketing systems often rely on manual counters, static websites, or phone-based reservations, resulting in long queues, booking delays, limited accessibility, and a lack of multilingual support. To address these challenges, this paper presents an AI-powered chatbot-based ticketing system designed specifically for museums and cultural centers. Using Natural Language Processing and conversational AI, the system allows visitors to book tickets, modify reservations, explore exhibition details, and receive real-time assistance through natural text or voice-based interactions. The chatbot operates across web, mobile, and kiosk platforms, ensuring 24/7 availability and inclusive access for diverse audiences.

The system integrates secure digital payments, automated confirmation, and QR-based ticket generation while prioritizing user privacy, encrypted transactions, and data protection. Multilingual capabilities help international tourists, elderly users, and individuals with limited digital literacy. For museum administrators, the system provides real-time analytics on visitor flow, ticket sales, peak hours, and revenue trends, supporting data-driven decision-making and operational planning. By reducing manual workload, minimizing human error, and accelerating the ticketing process, the solution enhances both visitor satisfaction and organizational efficiency.

Overall, the proposed system modernizes cultural ticketing infrastructure, promotes accessibility, and strengthens the connection between museums and global audiences, demonstrating how AI-driven conversational interfaces can shape the future of smart, user-centered cultural experiences.

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2. Similarity Index / Plagiarism Check report clearly showing the Percentage (%).

Appendix

3. SCREENSHOTS

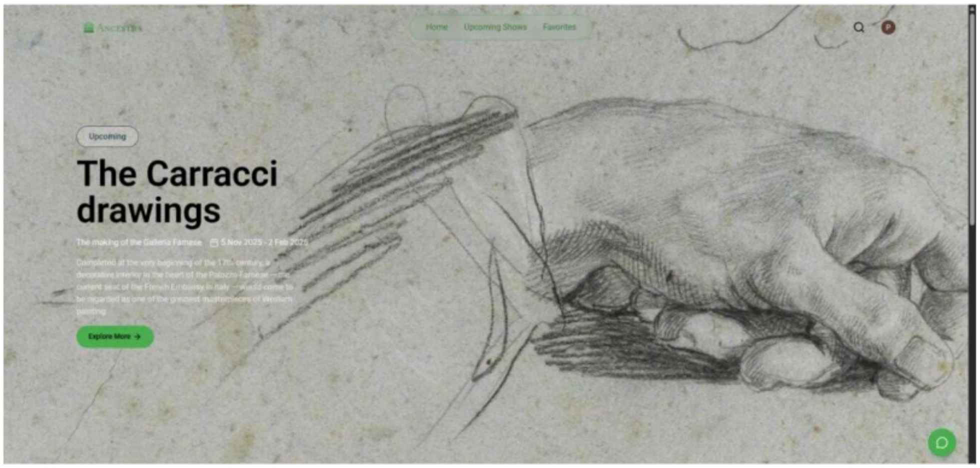

Fig A.1: Home Page

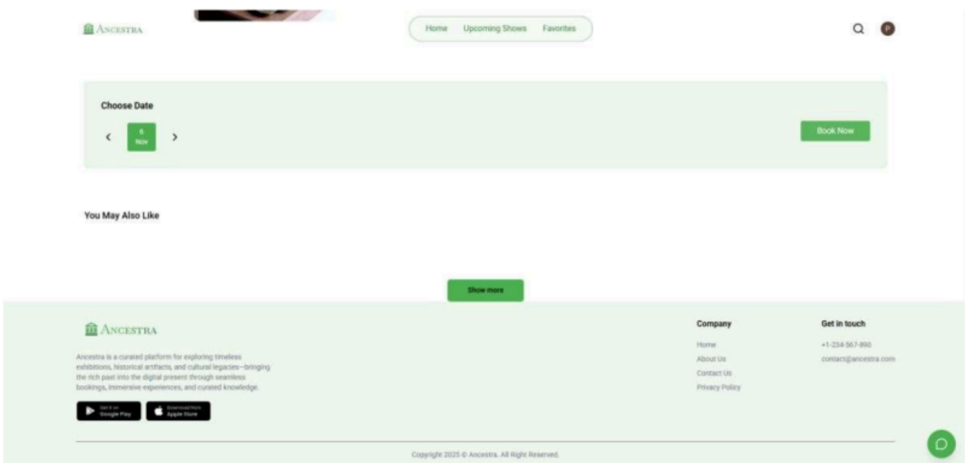

Fig A.2: Available Dates of Show

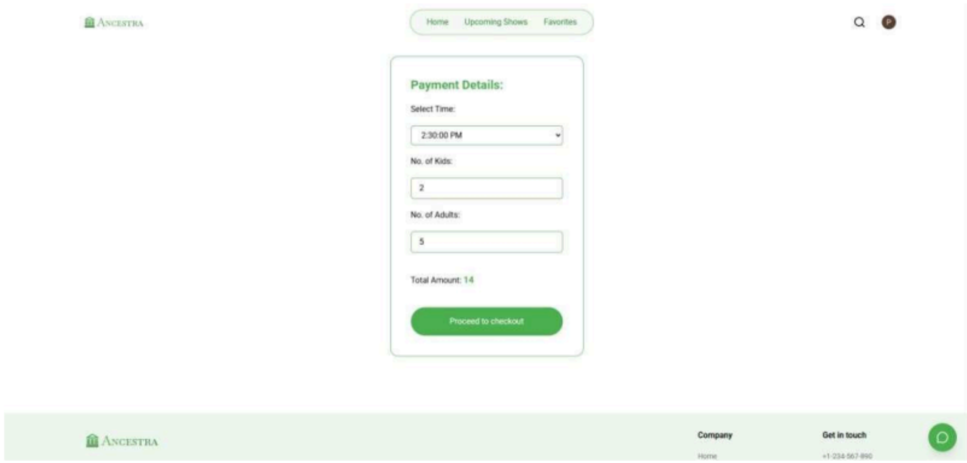

Fig A.4: Booking Page

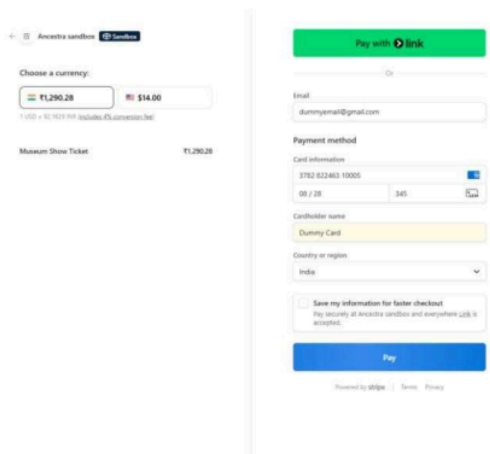

Fig A.5: Payment Page

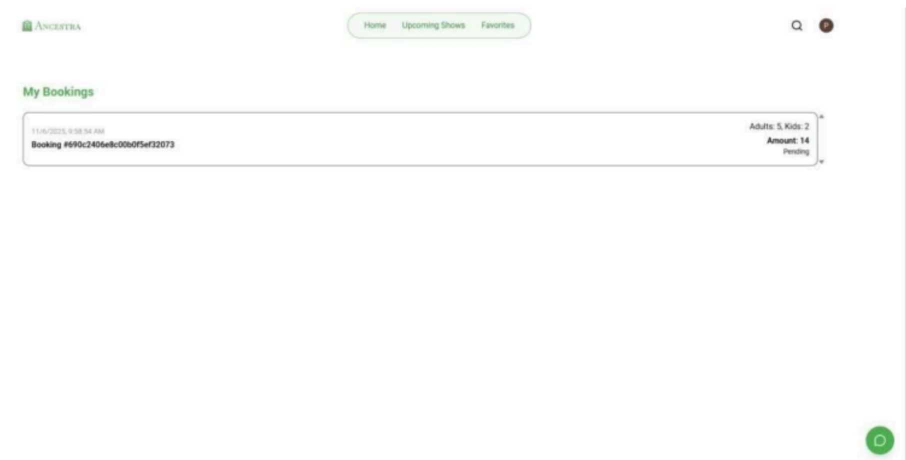

Fig A.6: Booked Shows Page

Fig A.7: AI Chat-Bot Tickets Booking

Smitha S P - (ISE_45) Capstone_Project_Report(from abstract to appendix)

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