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Posted Date: 30 September 2024

doi: 10.20944/preprints202409.2350.v1

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Article

Effects of Generative AI in Tourism Industry

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Abstract: In the dynamic and evolving tourism industry, engaging of stakeholders is essential for fostering innovation and improving service quality. However, tourism companies often struggle to meet expectations for customer satisfaction through interactivity and real-time feedback. While new digital technologies can address the challenge of providing personalized travel experiences, they can also increase the workload for travel agencies due to the maintenance and updates required to keep travel details current. Intelligent chatbots and other Generative Artificial Intelligence (GAI) tools can help mitigate these obstacles by transforming tourism and travel-related services, offering interactive guidance for both tourism companies and travellers. In this study, we explore and compare the main characteristics of existing responsive AI instruments, applicable in tourism and hospitality scenarios. Then, we propose a new theoretical framework for decision-making in the tourism industry, integrating GAI technologies to enable agencies to create and manage itineraries, and tourists to interact online with these innovative instruments. The advantages of the proposed framework are as follows: 1) providing a comprehensive understanding of the transformative potential of new generation AI tools in tourism and facilitates their effective implementation; 2) offering a holistic methodology to enhance the tourist experience; 3) unifying the applications of contemporary AI instruments in tourism activities and paves their further development. The study contributes to the expanding literature on tourism modernization and offers recommendations for industry practitioners, consumers, and local, regional, and national tourism bodies to adopt a more user-centric approach to enhancing travel services.

Keywords: generative artificial intelligence; dynamic itinerary planning; AI-driven travel suggestions; automated review summarization; interactive travel assistance; tourism industry; smart travel planning; AI powered customer service

1. Introduction

The tourism industry has undergone significant transformation with the rise of digital technologies. Initially, travel agencies provided basic information and options to travellers through static online brochures. Early digital methods for travel planning and customer service were manual, offering limited personalization. The next phase introduced online platforms with more flexible and accessible tools, enhancing user convenience and experience [1,2]. Recent advancements in Generative AI (GAI) have revolutionized the industry, introducing sophisticated tools like AI-powered virtual assistants and personalized travel recommendations. These innovations improve customer engagement by enabling highly tailored travel experiences and dynamic interactions. The rapid adoption of GAI has been driven by growing consumer demand for personalized and seamless travel solutions, setting a new standard in the industry [3–5].

GAI technologies, such as chatbots, virtual assistants, and conversational agents, have become essential tools in tourism. These applications facilitate interactions between service providers and tourists through text or voice interfaces. By automating routine tasks like answering common queries, delivering customer support, and handling basic transactions, GAI enhances efficiency and convenience for businesses and travellers alike [6,7]. Modern chatbots, for example, utilize advanced

capabilities like recognizing specific keywords and phrases, understanding user intent through contextual analysis and machine learning, and offering personalized responses tailored to individual needs [8,9].

According to a recent report by the World Economic Forum, the travel and tourism industry, one of the hardest hit by the COVID-19 crisis, is now on a path to recovery. In 2023, the Middle East saw the highest recovery rates in international tourist arrivals, surpassing pre-pandemic levels of 2019 by 20%. Europe, Africa, and the Americas also demonstrated strong recovery, each reaching around 90% of their 2019 levels [10].

This revival in the travel and tourism sector is driven by a variety of factors. Increasing disposable incomes, particularly in urban areas, are leading to a growing interest in travel. Additionally, the integration of GAI technologies plays a crucial role in supporting this recovery. According to a report by Precedence Research, a strategic market research company, the global generative AI market in travel was valued at USD 632.18 million in 2022 and is projected to reach approximately USD 3,581.95 million by 2032, with a CAGR of 18.94% during the forecast period [11].

GAI can enhance the travel industry by attractive content such as virtual previews and promotional videos, personalizing customer interactions with tailored itineraries, and real-time assistance. For tourist agencies, new generation AI streamlines operations by automating content creation and customer support, while also creating high-quality images and videos for promotional use. These capabilities improve both tourist agency efficiency and customer experience, driving engagement and growth in the sector.

The main goal of this study is to investigate the impact of GAI tools on the tourism industry, specifically focusing on their influence on operational effectiveness. To verify our assumptions, a practical experiment was conducted with tourism professionals and travellers in September 2024. The analysis of the collected data reveals how both industry professionals and customers perceive smart AI tools, providing insights into the evolving role of GAI in enhancing the travel experience.

The primary study tasks are as follows:

- Investigate the challenges, expectations, and benefits of using GAI in various tourism settings, such as personalized travel recommendations, booking processes, and customer service.
- Develop a systematic approach for applying intelligent AI in tourism, improving business processes and customer engagement.
- Assess the effectiveness of GAI tools in handling common tasks and queries in the tourism sector, and evaluate their ability to enhance user experiences.
- Offer practical recommendations for optimizing GAI applications to streamline operations and improve customer satisfaction in the tourism industry.

The main contribution of this study is the development of a new theoretical framework for integrating GAI tools into the tourism industry. This framework provides a unified approach for evaluating the perceptions of both consumers and industry professionals regarding AI-based interactions in digital tourism environments. The effectiveness of these AI tools is assessed using both traditional statistical methods and advanced decision analysis techniques. Early identification of issues arising from inadequate GAI deployment and usage can help mitigate costs, reduce time losses, and prevent negative outcomes such as misinformation, miscommunication, and errors, thereby minimizing broader economic impacts on tourism companies and travellers.

The remainder of this paper is structured as follows: Section 2 explores the key features of prominent GAI systems with a particular focus on their applications in the tourism industry. Section 3 reviews findings from existing research on the use of modern AI tools in tourism settings. Section 4 introduces a new integrated framework for deploying GAI in tourism operations. The verification section validates the proposed framework by testing its effectiveness and reliability through two case studies, ensuring that the framework is robust and applicable in diverse tourism scenarios. The paper concludes by summarizing key insights and outlining directions for future research.

2. State-of-the-Art Review of GAI Tools

GAI is revolutionizing the tourism and hospitality industries, offering advanced capabilities across various sectors. This section provides an overview of the primary characteristics of state-of-the-art GAI technologies. First, we categorize these tools using various criteria. Next, we compare the key features of the most widely used GAI platforms and systems within each category. Finally, we explore how these advanced AI technologies transform the tourist experience, from generating personalized travel recommendations and interactive voice responses to creating compelling visual content and immersive video experiences for travellers.

2.1. Taxonomy of GAI Tools

The latest GAI technologies leverage machine learning and deep learning algorithms to understand and generate natural language, images, and other content types. Trained on extensive datasets, these tools process user inputs to deliver relevant, contextually appropriate responses, creating innovative and engaging content while simulating human interaction. Each tool offers distinct features and capabilities, making the choice of the right GAI tool dependent on specific needs and the nature of the content or interaction. The following section provides a concise overview of the most commonly used GAI instruments and their applications.

GAI tools can be categorized based on various criteria. According to their core functions and modes of interaction, these tools are typically grouped into three categories: generative AI chatbots, virtual assistants, and voice assistants.

Generative AI chatbots, powered by Large Language Models (LLMs), generate human-like output for complex conversational tasks and content creation, primarily interacting through text.

Virtual assistants, like Siri or Google Assistant, have a broader scope, combining task management with conversational abilities. They interact through text, voice, and visual interfaces to manage tasks such as scheduling and information retrieval.

Voice assistants, such as Amazon's Alexa, focus on executing voice-activated tasks and providing information through spoken interaction. These tools are often integrated with smart devices for hands-free control.

Each category is tailored to meet different user needs, from creative content generation to practical task execution and hands-free device management. While not all of these tools are solely based on GAI technologies, GAI plays a crucial role in chatbots and serves a supplementary function in virtual and voice assistants, which incorporate a broader range of AI technologies.

The evolution of GAI chatbots has progressed from early task-specific, rule-based systems to advanced transformer architectures, especially those incorporating the self-attention mechanism. Unlike traditional AI models, transformers—such as those used in GPT-3 and GPT-4 LLMs—process entire input sequences in parallel, improving their ability to model complex, long-range dependencies. This architecture allows GAI chatbots to benefit from both unsupervised pre-training and supervised fine-tuning, resulting in significantly enhanced performance compared to earlier methods. Modern LLMs, trained on extensive and diverse datasets, enable these chatbots to generate highly accurate and contextually relevant multi-modal responses, demonstrating a deep understanding of user input.

Based on their primary output medium, GAI tools can be categorized as text-based, voice-based, image-based, or video-based:

Text-based AI tools enhance customer interactions by generating engaging marketing content, automating customer support, and providing personalized travel recommendations.

Voice-based tools facilitate real-time communication with travellers through virtual assistants and interactive voice response systems, streamlining bookings and inquiries.

Image-based GAI systems enhance visual content by generating travel visuals, virtual tours, and destination previews, improving customer engagement and decision-making.

Video-based tools offer dynamic, immersive experiences such as virtual destination walkthroughs, promotional videos, and personalized video guides, enriching the travel experience.

These advancements are transforming how tourists and travel agencies connect, making travel planning more interactive, personalized, and efficient.

As text-based GAI evolves, chatbots have become increasingly sophisticated, enabling more natural and contextually relevant interactions. Modern AI-powered chatbots are often multimodal, capable of processing and generating not only text but also other forms of media. This versatility enhances their application across various domains, including tourism, where they personalize travel experiences and streamline customer service.

2.2. GAI Chatbots and Their Features Comparison

In this section, we will explore six distinct chatbots that demonstrate the diverse capabilities and real-world applications of GAI-based chatbots.

Chat Generative Pre-trained Transformer (ChatGPT) (OpenAI, San Francisco, CA, USA, <https://openai.com/chatgpt>, accessed on 30 September 2024) (2022) is GAI chatbot built on OpenAI’s GPT-4 architecture. It uses a transformer-based neural network with 220 billion parameters, enabling it to generate coherent and contextually nuanced text. Trained on diverse and extensive datasets, ChatGPT excels in various applications, including conversational agents, content creation, and question answering. Its ability to comprehend and generate complex language patterns makes it ideal for delivering interactive and personalized user experiences.

Copilot (Microsoft, Redmond, WA, USA, <https://www.microsoft.com/en-us/edge/launch/bing-chat-features>, accessed on 30 September 2024) (2023), built on GPT-4, is integrated into the Microsoft Edge Microsoft Edge or Office apps as a sidebar or toolbar, providing AI-powered features for enhanced browsing, content creation, and data analysis, available through a Microsoft 365 subscription or preview. **Users can ask complex questions, obtain detailed answers, summarize content or use contextual assistance.**

Gemini (Google DeepMind, London, UK, <https://deepmind.google/technologies/gemini/>, accessed on 30 September 2024) (2023) represents a suite of advanced AI models designed for sophisticated responses. Gemini models are built upon large-scale transformer architectures, integrating reinforcement learning and neural network training techniques. They provide high-quality text generation, contextual understanding, and support for complex queries, enhancing user interactions across various applications.

Claude (Anthropic, San Francisco, CA, USA, <https://www.anthropic.com/claude>, accessed on 30 September 2024) (2023) is designed with a focus on ethical AI and user alignment. Claude models utilize transformer architecture with mechanisms ensuring safe and reliable interactions. By emphasizing interpretability and alignment with human values, Claude provides high-quality responses while minimizing risks associated with AI misuse or bias. This chatbot is particularly suited for applications requiring a high degree of safety and ethical consideration.

Perplexity (Perplexity AI, New York, NY, USA, <https://perplexity.ai/>, accessed on 30 September 2024) (2022) specializes in generating precise and relevant answers through its GPT-4 and Claude 3 LLMs. Perplexity handles complex queries and delivers accurate responses by leveraging extensive training datasets. Its focus on high-quality information retrieval and contextual understanding makes it a powerful tool for answering questions and providing detailed insights.

HuggingChat (Hugging Face, New York, NY, USA, <https://huggingface.co/chat/>, accessed on 30 September 2024) (2023) leverages the Hugging Face model library, including a range of transformer-based models like Meta Llama, Mistral, and Qwen. HuggingChat provides a platform for conversational AI, enabling users to deploy and customize various models for specific tasks. The platform supports text generation, dialogue management, and integration with other AI tools, making it suitable for diverse applications in natural language processing (NLP) and interactive systems.

Table 1 provides a comparison of key characteristics, including functionality, LLMs, supported platforms, access type, inputs, and outputs for the presented chatbots.

Table 1. Comparison between the most widely used generative chatbots.

Name	Functionality	LLM	Supported Platforms	Licencing Mode	Inputs	Outputs
ChatGPT	Conversational AI for generating human-like text and answering questions, code generation, multimodal	GPT-4	iOS, Android, Web	Free, Subscription (Pro)	Text prompts or multimodal instructions from users, images (in Pro version)	Human-like text or multimodal responses, including answers, summaries, recommendations, code snippets
Copilot	Answering questions, program code completion, and suggestions within code editors, multimodal	GPT-4, Codex	MS environment, iOS, Android, Web	Subscription (Microsoft 365), GitHub plan	Text prompts or multimodal instructions from users	Text or multimodal responses based on user queries, code generation
Gemini	Search-enhanced conversational AI with advanced text, image, and voice interaction capabilities, multimodal	Gemini (Ultra, Pro, and Nano)	Google Workspace, iOS, Android, Web	Limited access, Google services	Multimodal inputs (code, images, audio, videos, and PDF) along with text prompts	Text or multimodal responses for various tasks, code generation, content editing
Claude	Conversational AI with a focus on understanding and generating complex text, multimodal	Claude 3 (Haiku, Sonnet, Opus)	Web, Slack integration	Free, Subscription (Pro)	Natural language text, programming code and other input types	Text outputs for tasks like code generation, language translation, and complex reasoning, other output types
Perplexity	AI-powered search engine providing direct answers with sourced information, multimodal	GPT-4, Claude 3, Sonar 32k, GPT-4o	iOS, Android, Web	Free	Text queries or requests from users and other input types	Human-like text responses, summaries, translations, accurate information and other output types
HuggingChat	Conversational AI supporting various NLP tasks, including chat, summarization	Multiple LLMs (Mata Llama, Mistral, etc.)	Web, Open-source platforms	Free	Text prompts or questions	Text outputs, including answers and summaries

These GAI chatbots share common characteristics such as advanced NLP, the ability to engage in interactive conversations, and adaptability to various contexts. However, each has distinct strengths, making them more or less suited to different use cases.

Functionality: ChatGPT is highly user-friendly, free, and offers advanced features ideal for tasks like answering questions and providing recommendations. Copilot, employing the same LLM, can also handle specific queries, making it suitable for industrial purposes. Gemini excels with innovative features, while Claude stands out with its 200K context window and versatility, which is particularly beneficial for customer relationship management (CRM) tasks. Perplexity performs well overall but has slower response times, which could be a drawback in fast-paced environments, although it remains valuable for certain applications. HuggingChat is effective for basic customer interactions and general conversations. In summary, while some chatbots like ChatGPT and Claude are better

suited for industry-related tasks, all of these tools can be adapted to meet specific industry needs, with varying effectiveness depending on the use case.

Real-time internet access: ChatGPT-Plus, Copilot, Gemini, and Perplexity integrate search capabilities to fetch real-time information, providing up-to-date responses. Claude and HuggingChat do not include native browsing capabilities but can be integrated into systems that support real-time information retrieval.

LLM: The LLMs behind the abovementioned chatbots differ in architecture and training. ChatGPT, Copilot and Perplexity, based on OpenAI's GPT-4, excels in conversational abilities and general-purpose tasks. Copilot leverages OpenAI's Codex for coding and software development. Gemini uses advanced models for contextual understanding and integration across Google services. Claude focuses on ethical, safety-oriented interactions, Perplexity with Claude 3 LLM emphasizes robust question-answering capabilities, and HuggingChat provides flexible access to various models in its open-source ecosystem.

Supported platforms vary widely among these chatbots. ChatGPT is accessible across web browsers and mobile apps. Copilot is integrated into MS Edge, MS Office and coding environments like Visual Studio Code and GitHub. Gemini is embedded within Google's ecosystem, enhancing its accessibility across Google services. Perplexity can be accessed via its interface and integrated into applications through APIs. Claude provides access through its platform and APIs, often requiring subscriptions. HuggingChat, being open-source, supports a wide range of platforms through APIs and can be customized for various applications.

Access type: ChatGPT offers both embedded access via web and mobile apps and API integration. Copilot is available within MS products and code editors like Visual Studio Code. Gemini is embedded in Google's services, and Perplexity provides API access. Claude offers access through its platform and API, while HuggingChat is available as open-source software with both free and enterprise options.

Software licensing: ChatGPT has free and subscription options with different feature levels. Copilot is subscription-based, often part of MS products and GitHub's suite. Gemini is available through Google's service packages. Perplexity offers access via its interfaces and APIs with varying levels of access. Claude operates on a subscription model, and HuggingChat offers both free and enterprise access through its open-source platform.

Modality: The paid ChatGPT version (ChatGPT Plus) supports multimodal features, such as generating images through the DALL-E 3 model and interpreting various formats like text and images. Gemini has also native multimodal support, allowing it to handle and generate text, images, audio, and video. Copilot integrates multimodal features, including image generation through DALL-E and its tight integration with other Microsoft tools for document and media handling. Claude and Perplexity also support a variety of input and output types. HuggingChat, are primarily text-based and do not support full multimodality at this time.

Modality: ChatGPT Plus and Copilot support multimodal features like generating images through DALL-E 3. Gemini also supports multimodal inputs, handling text, images, audio, and video. Claude and Perplexity also support various input and output types, while HuggingChat is primarily text-based and lacks full multimodal support.

Response quality and accuracy: ChatGPT, Copilot, and Perplexity provide high-quality responses but can sometimes generate inaccuracies or hallucinations. Claude excels in detailed understanding and accuracy in complex conversations. HuggingChat varies in quality depending on the model used but generally provides accurate and relevant information, especially when customized.

While GAI chatbots offer significant benefits to businesses and users, they also pose challenges:

- They may generate biased or misleading information if trained on prejudiced or inaccurate data, leading to poor recommendations or incorrect details.
- Malicious actors can manipulate chatbot responses by inputting deceptive information.
- Training large GAI models requires substantial computational power and energy, raising environmental and operational cost concerns.

Addressing these challenges is essential to ensure that GAI-driven applications are effective and responsible.

This section compared widely used GAI chatbots, highlighting differences in functionality, LLM size, multimodal capabilities, and access methods. Recent advancements in chatbots like ChatGPT, Copilot, Gemini, and Perplexity have enabled real-time web access, allowing them to search the internet and provide up-to-date information. These developments represent a significant leap forward in enhancing user interactions, offering more natural and efficient ways to meet diverse needs.

The next section offers an overview and comparison of GAI software for image and video creation, focusing on their features and use cases.

2.3. GAI Tools for Image and Video Creation

GAI tools for multimedia creation are revolutionizing the tourism industry by transforming how travel experiences are visually represented and marketed. Traditionally, creating compelling travel visuals required extensive manual editing and stock footage. Today, advanced generative AI systems can produce realistic and engaging images and videos that showcase diverse travel destinations and experiences. These tools leverage deep learning models to generate original visual content based on patterns learned from large datasets, enabling the creation of travel media that closely resembles real-life scenes and attractions.

Unlike earlier methods that relied on static images and pre-recorded videos, modern generative AI tools can dynamically generate customized visuals based on user preferences or specific travel themes. This capability is particularly valuable in tourism, where personalized and high-quality content can significantly enhance marketing campaigns and destination promotions. For instance, AI can create stunning visual representations of travel destinations, generate virtual tours, or produce promotional videos that highlight unique aspects of a location.

The development of GAI tools has transformed image and video creation by introducing new algorithms for generating detailed and realistic visuals. In this section, we examine and compare leading platforms and systems for generative image and video creation in the tourism sector, focusing on their features, effectiveness, and impact on travel marketing and customer engagement.

GAI Tools for Image Generation

DALL-E (OpenAI, San Francisco, CA, USA, <https://openai.com/index/dall-e-3>, accessed on 30 September 2024) (2021) uses advanced generative models based on GPT to create highly detailed and contextually relevant images from textual descriptions. This tool allows users to generate new images or edit existing ones through inpainting, making it suitable for creative design, marketing visuals, and concept art. DALL-E 3 is integrated with ChatGPT, enabling better understanding of prompts and the generation of more detailed images. It is available through ChatGPT Plus and Enterprise subscriptions and via API.

Midjourney (Midjourney Inc., San Francisco, CA, USA, <https://www.midjourney.com>, accessed on 30 September 2024) (2022) is known for its focus on artistic and stylistic image generation. It excels at creating artistic outputs with diverse styles for social media content, graphic design, and artistic creation. However, it may produce more abstract results and is less effective for photorealistic imagery. A drawback of Midjourney is the need for counterintuitive prompts to gain greater control over the output image.

Stable Diffusion (Stability AI, London, UK, <https://stability.ai/stable-image>, accessed on 30 September 2024) (2022) employs diffusion models to generate high-quality images by gradually refining them based on text prompts. As an open-source tool, it offers significant customization and is ideal for personalized image creation in design mockups and content generation.

Ideogram.ai (Ideogram, Toronto, Canada, <https://ideogram.ai>, accessed on 30 September 2024) (2022) specializes in generating images with embedded text. Its limitations include low customization options and limited applicability for purely visual content.

Runway ML (Runway AI, Inc., New York, NY, USA, www.runwayml.com, accessed on 30 September 2024) (2018) offers a suite of generative models for creative tasks such as image synthesis

and style transfer. It supports diverse creative projects, including interactive art and video production, though its complexity arises from the integration of multiple models.

In comparing the capabilities of these GAI tools for image generation, DALL-E and Midjourney excel in different styles (realistic vs. artistic), while Stable Diffusion offers high flexibility and customization. Ideogram.ai specializes in text-image integration, while Runway ML provides a broader range of functionalities, covering both image and video generation.

Each tool has its limitations: DALL-E and Midjourney have constraints regarding customization and real-world accuracy, while Stable Diffusion requires a certain level of expertise. Ideogram.ai is focused mainly on text and image design, and Runway ML emphasizes integration with design tools over deep customization.

DALL-E and Stable Diffusion are well suited for creating realistic and customized visuals, while Midjourney is best for producing artistic content. Ideogram.ai is ideal for generating text-driven media, and Runway ML excels at creating dynamic multimedia presentations. By leveraging these tools, various industries can develop visually appealing and informative materials that enhance user engagement, highlight key features, and showcase unique offerings. Text-to-image tools offer a versatile platform for elevating marketing efforts and communication strategies across multiple sectors.

GAI Tools for Video Generation

Sora (OpenAI, San Francisco, CA, USA, www.openai.com/sora, accessed on 30 September 2024) (not released) offers generative capabilities for video content, allowing users to create engaging animations and dynamic video sequences from text prompts. It supports features like voiceovers, scene generation, and style customization, making it valuable for creative projects and storytelling. However, it requires substantial computational resources and may occasionally produce results that lack realism or exhibit inconsistencies.

Runway ML (Runway AI, Inc., New York, NY, USA, www.runwayml.com, accessed on 30 September 2024) (2023) extends its generative capabilities to video content starting from Gen-2, enabling users to synthesize and edit video sequences. The tool supports video editing, style transfer, and frame generation, making it a useful resource for video production and creative projects.

Synthesia (Synthesia, London, UK, <https://www.synthesia.io>, accessed on 30 September 2024) (2017) utilizes deep learning to create synthetic video content featuring virtual avatars, offering features such as talking-head videos and text-to-speech capabilities. It is especially valuable for corporate training, marketing, and educational content, though it is limited to scripted and avatar-based content.

DeepBrain (DeepBrain AI, Palo Alto, CA, USA, <https://www.deepbrain.io/>, accessed on 30 September 2024) (2016) focuses on generating realistic avatars and synthesizing video content. It provides high-quality avatar generation and video editing features, useful for virtual assistants, interactive media, and educational videos. However, it may require fine-tuning for specific use cases and is limited to avatar-based content.

Pictory (Pictory, Bothell, WA, USA, <https://pictory.ai>, accessed on 30 September 2024) (2019) converts text into engaging video content, offering templates and customizable elements. This tool is well-suited for creating marketing videos, social media content, and educational materials from text input, though it may lack advanced editing features and can be constrained by predefined templates.

Lumen5 (Lumen5, Vancouver, Canada, <https://lumen5.com>, accessed on 30 September 2024) (2017) transforms text and images into video content using AI-driven automated editing. It is effective for content marketing, video summaries, and social media posts by converting articles and blog posts into videos using stock footage and templates. However, it may not support highly customized or complex video needs.

Rephrase.ai (Adobe, San Francisco, CA, USA, <https://www.rephrase.ai>, accessed on 30 September 2024) (until 2023, now a waitlist for GAI-based Firefly video model is open) generates personalized video content featuring virtual presenters using AI avatars and text-to-speech technology. It integrates with marketing automation tools, making it ideal for personalized marketing

and customer engagement. However, it focuses primarily on presenter videos and may not address broader video creation requirements.

The advantages of these GAI systems for video generation are as follows: Sora excels at creating videos from text prompts, including animations and voiceovers, making it suitable for creative outputs. Runway ML offers both video and image generation with a range of editing tools, providing a comprehensive platform for creators. Synthesia specializes in AI-generated videos featuring realistic avatars and voiceovers, making it ideal for businesses and educational content. DeepBrain is optimized for real-time video generation and manipulation, catering to industries requiring fast results. Pictory focuses on creating videos from scripts, emphasizing marketing and storytelling. Lumen5 is designed to transform blog posts and articles into engaging videos using templates and media libraries to streamline content creation. Rephrase.ai generate personalized videos using text input, featuring dynamic avatars and voiceovers tailored to individual viewers.

Despite its advantages, Sora may have limitations in realism and customization compared to more specialized tools. Runway ML, while powerful, emphasizes integration, and some features may not be as advanced as those found in dedicated video editing software. Synthesia is restricted to avatar-based videos, which may not fit all content types. DeepBrain's focus on quick, real-time applications may limit its advanced editing capabilities. Pictory offers limited customization options for advanced users, focusing more on speed than detailed edits. Lumen5 may not provide the depth of customization desired by advanced users, relying on templates. Rephrase.ai, while excellent for personalization, may struggle with generating complex narratives or more sophisticated storytelling beyond basic prompts.

Generative AI tools for image and video creation have revolutionized content generation by enabling users to produce high-quality, personalized, and stylistically diverse media with ease. Image generation tools like DALL-E 2, Midjourney, and Stable Diffusion offer capabilities that range from detailed visual creations to artistic transformations, making them valuable across various creative industries. On the video front, tools such as Runway ML (Gen-2), Synthesia, and DeepBrain facilitate the creation and editing of dynamic video content, including avatars and personalized marketing videos. Despite their advanced functionalities, these tools often require substantial computational resources and careful management to ensure quality and mitigate biases. As technology evolves, GAI tools will continue to expand the possibilities for creative and practical applications across multiple domains.

2.4. Applications of GAI Instruments in Tourism Industry

Since the early 2000s, the tourism industry has increasingly adopted innovative technologies to enhance the travel experience, with AI tools playing a pivotal role. In the early 2020s, as conversational AI technology advanced, chatbots became an integral part of tourism platforms, offering personalized and interactive experiences for travellers and tourism professionals. These chatbots stand out for their ability to simulate human conversation and provide real-time assistance, enhancing traveller engagement and satisfaction. Later, generative AI (GAI) further revolutionized the tourism industry with its diverse capabilities, ranging from personalized travel recommendations to dynamic content creation and immersive virtual experiences. By leveraging advanced algorithms, GAI can analyse vast datasets to predict tourist trends, optimize travel itineraries, and improve customer service through interactive, multilingual support. The widespread adoption of GAI chatbots is driven by their potential to transform customer interactions, offering instant, personalized responses that enrich the overall travel experience.

Key characteristics of GAI chatbots in the tourism industry include:

1. Conversational assistance – They respond to traveller inquiries and provide detailed information about destinations, accommodations, and activities.
2. Multi-modality – They support various communication modes, including text, voice, and visual elements, to cater to diverse user preferences.
3. Multilingual support – They offer multilingual capabilities to assist international travellers and cater to a global audience.

4. Cost-effectiveness and scalability – They handle a large volume of interactions cost-effectively, making them suitable for both small businesses and large travel agencies.
5. Integration with other systems – They integrate with booking systems, CRM platforms, and travel databases to provide seamless service.
6. Data analytics and insights – They offer valuable analytics and insights to tourist operators, helping to improve service offerings and customer satisfaction.

Compared to traditional customer service channels and travel advisory systems, GAI chatbots offer a more interactive and personalized tourist experience. Unlike static information sources, these chatbots can provide real-time assistance and adapt to individual traveller needs. They are versatile, capable of handling a wide range of tasks from booking support and travel advice to local recommendations and itinerary adjustments.

The adoption of GAI chatbots in tourism is rapidly expanding due to their advanced capabilities in understanding and generating natural language. They provide effective solutions for streamlining operations and enhancing traveller interactions, leading to improved operational efficiency. GAI chatbots have the potential to significantly transform the tourism industry by offering innovative and personalized services, making travel planning and management more efficient and engaging.

GAI tools extend beyond chatbots, offering transformative applications across various aspects of the tourism industry. For example, image generation tools create visual content for promotional materials, enhancing destination marketing campaigns with photorealistic images of attractions and accommodations. Video synthesis technologies enable the creation of immersive virtual tours, allowing potential travellers to explore destinations dynamically and engagingly before making travel decisions. Additionally, GAI-powered recommendation systems analyse user preferences and behaviours to provide personalized travel itineraries and tailored suggestions, significantly improving the travel planning process. These advanced generative tools contribute to a more interactive and personalized approach to tourism, reshaping existing travel services.

3. Related Work

3.1. Theoretical Frameworks for Application of GAI in Tourism

In this section, we review the characteristics of existing frameworks for tourism services based on GAI.

Some studies focus on distinct aspects of specific GAI chatbot applications. Wong et al. [12] proposed a framework to examine ChatGPT's role in enhancing the tourist decision-making process across the pre-trip, en-route, and post-trip stages. Unlike traditional methods, ChatGPT enables tourists to actively seek relevant information through a question-and-answer format. This approach simplifies planning by reducing the need to sift through large amounts of data and compare options [12].

Gu [13] developed a theoretical framework for integrating ChatGPT into the tourism industry ecosystem. To evaluate ChatGPT's impact on consumer decision-making and the personalization of travel experiences, the author collected two datasets—one from a structured survey of tourists and another from in-depth interviews with tourism experts. Analysis of these datasets provided empirical evidence supporting the efficiency and personalization offered by AI in travel planning, as valued by respondents [13].

Vena-Oya et al. [14] conducted a study to assess whether tourists are prepared to adopt chatbots as a new service technology. The authors proposed a framework for evaluating electronic service quality based on six factors: information quality, competence, security, empathy, reliability, and responsiveness. Experimental results confirmed that user perceptions of these six dimensions of service quality differ between newer chatbot technologies and more mature ones [14].

Other researchers have developed broader frameworks for implementing GAI in business organizations, though they primarily focus on specific aspects of business processes and particular tourism industry stakeholders.

Abrokwah-Larbi [15] presented a theoretical framework based on dynamic capabilities theory to guide the use of GAI in SMEs, aiming to improve customer personalization (CP). By analysing

literature on GAI, deep learning, smart data, IoT, and CP, the relationship between GAI and CP was studied theoretically. However, in this study no empirical evidence exists to support the feasibility of this framework [15].

Dogru et al. [16] introduced a conceptual framework for GAI applications across various functional areas of hospitality and tourism firms, highlighting the potential for both co-creation and co-destruction of value. Their REFLECT model addresses resource-based, ethical, financial, legal, educational, cultural, and technological mechanisms. This framework serves as a guide for future GAI research relevant to hospitality and tourism management [16].

Gajić et al. [17] developed a PLS-SEM-based framework to explore the impact of AI on customer perceptions and behaviour in the restaurant, airline, and hotel sectors within Iran's hospitality industry. The findings reveal statistically significant relationships between AI quality and customer engagement metrics, such as trust and brand loyalty. However, this study focuses exclusively on three segments of the hospitality business in a developing country, which may limit its generalizability to other sectors or regions [17].

Although several studies have worked to develop frameworks for the use of GAI and intelligent chatbots in tourism, these frameworks have notable shortcomings:

- They often fail to fully address the operational aspects of tourism management, overlooking essential elements like customer engagement, visitor experience enhancement, and efficient service delivery.
- Existing frameworks typically focus on specific tourism services or cater to particular stakeholders in the tourism process, such as travellers, tour operators, hospitality providers, or government tourism bodies.
- They generally evaluate the impact of GAI tools in tourism by measuring customer satisfaction, rather than providing detailed algorithms for objective assessment.

Despite these efforts, a universally accepted framework for the design, development, and implementation of GAI tools in the tourism industry is still missing.

3.2. Measuring the Quality of GAI Services in Tourism

Another aspect of GAI studies involves evaluating their performance in various tourist activities and comparing the results with those achieved by traditional digital approaches.

Wong et al. [12] conducted a study on the prospects and challenges of utilizing GAI as decision-making tools during the travel stages. The authors presented various scenarios demonstrating how ChatGPT can enhance tourists' experiences throughout these travel phases. The results revealed that these value-added autonomous services provide cost-effective solutions and offer personalized information, simplifying the travel experience for tourists [12].

Gu [13] explored the intersection of ChatGPT and consumer behaviour in tourism by using both structured surveys and in-depth interviews to evaluate variables related to consumer satisfaction, perceived personalization, and the overall impact of ChatGPT on the decision-making process. The data analysis provided empirical evidence for the significant role of GAI in transforming the tourist experience, aligning with existing trends toward AI adoption in service industries [13].

Vena-Oya et al. [14] analyzed attitudes towards service quality among respondents from two countries with differing levels of DL. The study was based on survey questions addressing various dimensions of tourism service delivery. ANOVA results showed an interaction effect between technology type and country on participants' overall evaluation of the received service quality. The findings confirmed that DL moderates the perception of new GAI technology compared to well-established communication methods [14].

Miao et al. [18] investigated the relationship between text-to-image AI tools and the tourism experience. The authors evaluated image generators such as Midjourney and Stable Diffusion using a rubric corresponding to each phase of the tourism journey—anticipation, on-site, and recollection/reflection. They concluded that narration-to-image generation can enhance the memorability of tourism activities. The use of AI-generated imagery as a complementary form of

artistic expression allows for interpretation and transformation, making the tourism experience an ever-evolving process [18].

Zhang et al. [19] examined the quality of professional-generated content (PGC) and AI-generated content (AIGC) on a digital tourism interpretation platform in China, focusing on informativeness, emotional appeal, and empathy. Content analysis and ANOVA revealed that AIGC exhibited relatively lower content quality compared to PGC across all three dimensions. The authors concluded that, in terms of interpretive content, AI cannot fully replace human professional interpreters. However, the potential for human-machine collaboration in digital tourism interpretation remains promising [19]. Similar findings were reported by Volchek and Ivanov [20], who evaluated ChatGPT-generated travel itineraries for three destinations against those developed by tourism experts using 11 evaluation criteria. The results showed that for popular destinations, the chatbot created factually correct and feasible itineraries, but only included well-known attractions, reducing the usefulness of the itineraries. Therefore, ChatGPT may serve as an initial rather than a final or sole point in the travel planning process [20].

Although smart AI-based tools are relatively new to tourism, numerous studies have explored their impact on the travel experience. As the functionality of these tools continues to evolve, regular assessments and data analysis are essential to objectively evaluate their quality and progress. However, these studies often have a limited scope, focusing on specific GAI tools, travel stages, or tourist activities. Consequently, there is a need for a comprehensive conceptual framework that can encompass a variety of activities across the business models of tourism companies. Such a framework would provide a broader understanding of the potential of GAI tools in tourism and support their effective implementation. To validate this new framework, various evaluation criteria could be utilized, ranging from specific quality metrics such as travel relevance, completeness, and consistency to broader indices like the Service Quality Index and Experience Diversity Index, as well as established standards like SERVQUAL or ISO 10002 for measuring customer satisfaction.

4. Framework for GAI-Assisted Business Processes in the Tourism Industry

Different travel service providers—such as travel agencies and tour operators—play distinct roles within the tourism industry, acting as intermediaries between tourists and their travel experiences. Travel agencies focus on front-end services, such as personalized trip planning, booking, and logistics, ensuring a seamless experience through direct engagement with clients. Tour operators, on the other hand, manage back-end processes, creating comprehensive travel packages by coordinating with suppliers and negotiating rates.

The digitization of tourism business processes has introduced new tools that optimize these operations, but it also presents challenges, such as preserving personalized service in an increasingly automated environment. While tour operators handle many aspects of travel planning, individual tourists still have the option to self-organize their trips. In the following section, we will explore how GAI can enhance business processes within travel service providers and improve the overall travel experience for both organized and independent travellers.

To address the limitations outlined in Section 3, we have developed a conceptual framework (Figure 1) that provides a comprehensive approach to managing both the challenges and opportunities of integrating GAI tools for optimizing business operations in tourism companies. This framework highlights the use of intelligent AI tools (represented by a green icon in Figure 1) for managing trips within a hybrid tourism environment, combining both physical and virtual elements. It is structured into five stages, considering the perspectives of both travel service providers and tourists.

Stage 1. Before Travel

The employees of tour operators are responsible for planning the overall travel structure and content, which includes outlining itineraries, setting budgets, scheduling activities, organizing necessary resources, and establishing evaluation criteria. This pre-planning stage also involves defining travel objectives, selecting destinations, and arranging the sequence of activities. Tourists should familiarize themselves with the travel plan provided by the agency or create one

independently if traveling individually. Feedback tools such as questionnaires and surveys can be used to collect data on consumer attitudes toward the travel experience.

During this phase, tourists are encouraged to conduct an information search and evaluate alternatives to ensure their preferences align with the proposed travel plan. If they have any questions or concerns about the travel package, they should consult their agency for clarification on requirements, expectations, or specific activities. GAI tools can assist by suggesting various options and alternatives for organizing the trip, enhancing tourist awareness, and aiding in the evaluation of different destinations. Travel agency employees should take into account factors such as country-specific requirements, travel prerequisites, and tourists' preferences. While final decisions are guided by the employees, individual tourists can utilize GAI tools to create personalized travel plans, manage their time effectively, and budget according to their specific needs.

At this stage, GAI acts as a supportive tool, assisting both travel agency employees and tourists in the decision-making process, while the expertise of the employees and the preferences of the tourists shape the overall travel experience.

Stage 2. Before Itinerary

The second stage involves activities focused on preparing for the itinerary. The agency representative or the tourist sets itinerary objectives, outlining what the tourist can do during each component, such as transportation, site visits, or attending events. Feedback tools, such as questionnaires and surveys, can be prepared to collect data on consumer attitudes toward the itinerary. Before beginning the trip, tourists can read reviews from previous visitors or search for relevant information to better prepare for the upcoming activities.

During this stage, GAI can provide access to digital itinerary materials, such as brochures or other multimedia resources, allowing tour guides and tourists to engage with them via a chat interface. GAI acts as a supportive tool for both agency employees and individual tourists, facilitating a more informed and personalized experience. In the next stage, the tour guide collaborates with tourists to determine the duration and frequency of specific activities, ensuring the itinerary aligns with their interests and preferences.

Stage 3. During the Itinerary

During the itinerary stage, tourists visit attractions and participate in various engaging events, either with or without the guidance of tour agency representatives. Travellers immerse themselves in the experience by actively participating in tour activities, asking questions to clarify any misunderstandings, and collaborating with peers on group tasks. They can also apply newly acquired knowledge in game-based activities involving problem-solving scenarios. Meanwhile, tour guides play a crucial role in encouraging active participation and addressing any concerns that arise. They may adjust the pacing or delivery of services based on tourist feedback and engagement levels.

At this stage, the role of GAI is minimal, as most activities occur in real-time and require direct, simultaneous communication. This is reflected in Figure 1, where the smaller size of the GAI icons indicates a reduced role for AI. However, GAI tools can still support tour guides and tourists through interactive features or virtual tours related to upcoming activities.

During this stage, the focus is on direct interaction and engagement in tourist activities, making GAI tools are less prominent compared to previous stages.

Stage 4. After the Itinerary

After the itinerary, the travel agency can organize remote meetings or virtual consultations to address any remaining questions or concerns tourists may have. This period offers tourists an opportunity to reflect on their experiences, review their activities, and participate in online discussions about their trip. They might create and share multimedia materials, such as photos or videos, to document and share their experiences on online forums or social media. Additionally, tourists may seek further resources, join online communities related to their destination, or stay in touch with tour guides for advice on next itineraries.

For the travel agency, GAI can streamline post-itinerary processes by automating administrative tasks, such as generating personalized follow-up communications and offering tailored recommendations for future itineraries. GAI tools can also assist tourists by providing

supplementary resources, answering follow-up questions, and supplying additional guiding materials related to their recent trip. This automation allows staff to dedicate more time to addressing individual needs and handling more complex queries.

During this phase, the agency can also gather feedback from tourists regarding their itinerary experiences. Key satisfaction metrics might include:

Overall experience: Satisfaction with the entire itinerary, including accommodations, activities, and services.

Activity quality: Contentment with the specific activities included in the itinerary.

Service efficiency: Evaluation of the responsiveness and support provided by the travel agency.

Itinerary convenience: Assessment of how well the itinerary met the tourists' expectations and needs.

The itinerary satisfaction threshold θ_i may also include measures such as satisfaction with specific activities, the overall pacing of the schedule, and the quality of accommodations. For instance, if satisfaction with key activities or the convenience of the itinerary falls below 75%, adjustments may be required to better meet traveller expectations for next itinerary.

Individual tourists can also use these metrics to make quick adjustments to their itineraries as needed.

Stage 5. After the Travel

After the travel concludes, both tourism agency employees and tourists engage in activities to wrap up their experiences. Employees finalize travel reports, reflect on the effectiveness of various activities, and gather comprehensive feedback from tourists. This feedback is used to assess overall travel satisfaction, identify areas for improvement, and update travel materials to enhance future offerings. Itineraries may be adjusted based on the feedback, and preparations for upcoming trips incorporate insights from the received feedback.

Tourists, meanwhile, review their overall experience, reflecting on the outcomes of their trip and identifying areas for improvement in future travel plans. They evaluate which aspects of their trip met their expectations and which did not, providing feedback through surveys or discussions with peers to share insights. Additionally, they may seek further opportunities to engage with their travel interests by exploring new resources, participating in related activities, or planning future travels to enrich their experiences.

GAI can play a supportive role in this phase by analysing the collected feedback to identify patterns and trends. It can generate personalized travel offers and suggest future trips tailored to individual preferences and past experiences. For example, GAI can recommend destinations or activities aligned with a tourist's interests based on their previous feedback and travel history, helping them discover new opportunities they may not have considered.

Furthermore, GAI-driven analytics provide travel agencies with actionable insights to refine their offerings and enhance the overall travel experience. For instance, if satisfaction with certain activities or the overall convenience of the trip falls below a predefined threshold θ_t , the agency can adjust services and itineraries to better meet traveller expectations and improve future offerings.

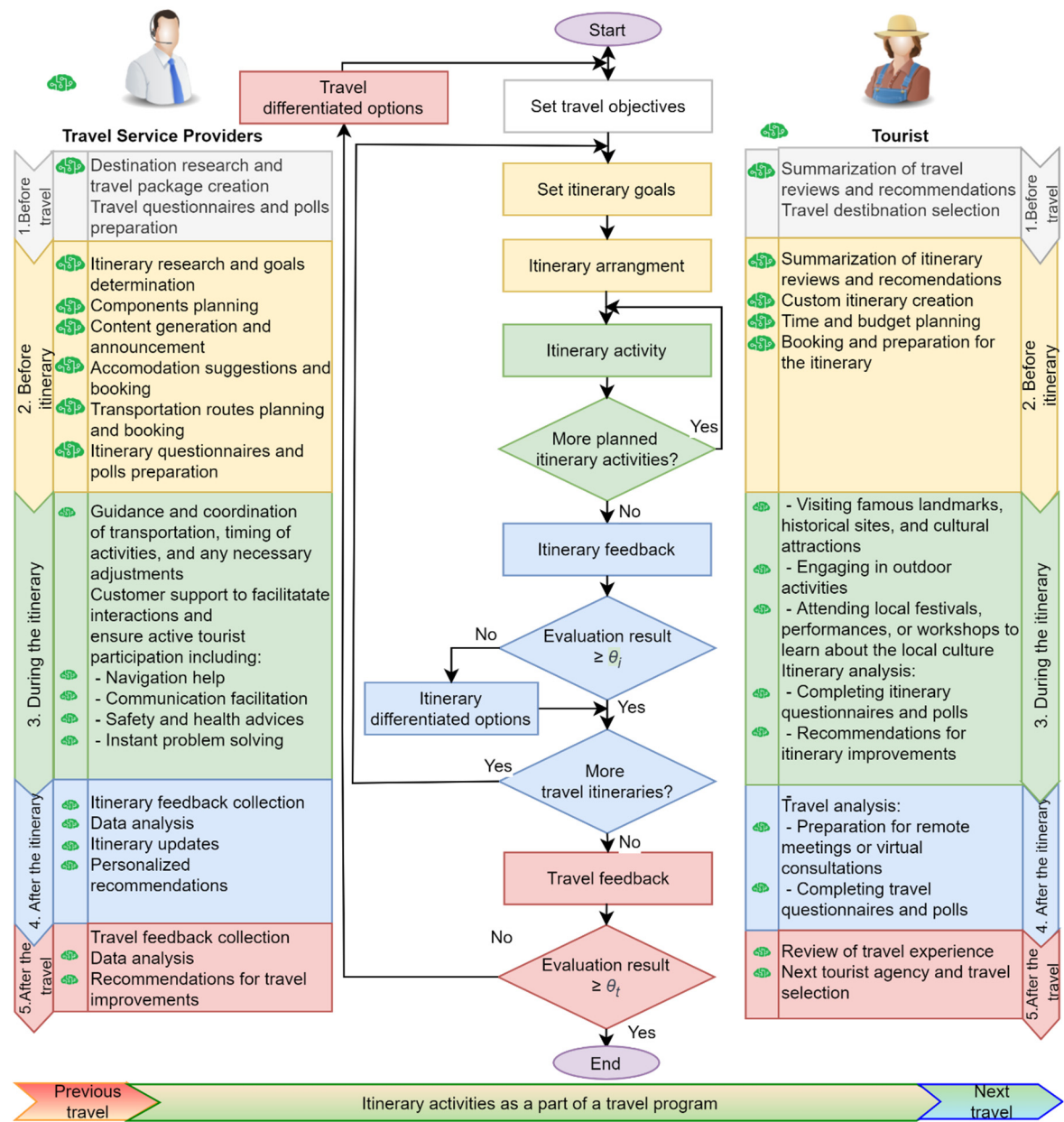


Figure 1. Framework for GAI application in tourism context.

Note: The variables θ_i and θ_t represent the minimal acceptable thresholds for itinerary satisfaction and overall travel satisfaction from the perspectives of both tourists and businesses. The itinerary satisfaction threshold θ_i could include metrics such as satisfaction with specific activities, the pacing of the schedule, and the quality of accommodations. The travel satisfaction threshold θ_t might cover broader aspects, including the overall trip experience, comfort, and value for money.

In the proposed framework for GAI applications in tourism, two critical checkpoints assess both tourist and business outcomes: itinerary satisfaction and overall travel satisfaction. For itinerary satisfaction, thresholds might include a minimum of 70% positive feedback for accommodation quality, 75% for itinerary enjoyment, and 80% for digital experiences, prompting improvements if these levels are not met. On the business side, satisfaction thresholds could involve a 60% customer retention rate, 85% service efficiency, and a 10% revenue increase from GAI-driven initiatives, with underperformance leading to strategic adjustments. Travel satisfaction is also evaluated, with tourists expected to provide at least 80% positive feedback on their overall experience. If business metrics such as repeat bookings or positive reviews fall below established thresholds, it signals the need for

further enhancement of services and GAI tool utilization. These checkpoints ensure continuous improvement in both customer satisfaction and business performance within the tourism industry.

According to the proposed framework, GAI tools have the potential to significantly enhance both business processes for tourism intermediaries and overall tourist satisfaction. GAI can facilitate communication, offer guidance during trips, provide valuable multimedia resources, and assist with various travel-related services. For tourism agencies, GAI can handle tourist inquiries, save employee time, and deliver immediate feedback, streamlining operations. However, it is crucial to note that critical decisions regarding travel planning and management are still made by agency representatives. GAI is designed to support and augment employee expertise and decision-making, not replace them. For individual tourists, GAI offers instant responses to questions, reduces wait times, and enhances the overall travel experience, with personalized recommendations that cater to each traveller's preferences and needs. Additionally, GAI tools can customize the tourist experience to align with individual preferences and needs.

GAI offers valuable capabilities throughout all stages of the travel experience—from planning to the post-trip period—for both tourism companies and individual travellers. During the planning phase, GAI helps agencies create personalized travel experiences by analyzing customer preferences and streamlining logistical arrangements. Individual tourists can use GAI to design custom itineraries and manage budgets. In the execution phase, GAI provides real-time updates, navigation assistance, and safety alerts, all of which enhance the overall travel experience. In the post-trip stage, GAI assists in gathering feedback and insights to help agencies refine future offerings, while also helping tourists reflect on their experiences by suggesting new destinations and activities based on their preferences.

Integrating GAI into travel activities aligns with key tourism principles such as accessibility, accommodation, attractivity, activities, and amenities (5 A's of tourism). This technology allows tourism agencies to focus on essential aspects of each travel experience, address potential shortcomings, and improve tourist satisfaction. For tourists, the interactive nature of GAI facilitates deeper engagement with new countries, places, and cultures. GAI is applicable across various types of tourism, including historical, cultural, and alternative tourism. By allowing tourists to plan trips based on their personal interests and preferences, GAI contributes to a more personalized and comprehensive tourism experience.

Tourist agency representatives can use the methodology described in the following section to assess the efficiency of GAI in a specific travel context.

5. Verification of the Proposed GAI-Based Travel Framework

To assess the applicability of the proposed framework for GAI-enhanced tourism activities, this section uses evaluation metrics to measure the performance of GAI tools from the perspectives of both tourism companies and individual (self-organized) tourists.

The effectiveness of the proposed framework was tested through a practical experiment involving six chatbots: ChatGPT, Copilot, Gemini, Claude, Perplexity AI, and Hugging Face Chat. The chatbots were assigned two tasks—one focused on preparing for international travel and the other on organizing local travel arrangements. Detailed descriptions of these tasks are presented below.

Task #1.

Explore North Greece's hidden gems

Plan a 5-day trip to visit the most captivating places in Northern Greece with a budget of 2,000 euros (excluding flight tickets). The journey should begin in Thessaloniki and should include balanced itineraries of cultural, historical, and natural attractions. Accommodations, meals, transportation, and activities must be carefully selected to stay within the budget.

Task #2.

Eco-adventure around Sofia, Bulgaria

Plan a 5-day trip to explore beginner-friendly eco-paths near Sofia, Bulgaria, with a budget of 1,000 euros (excluding flight tickets). Starting from Sofia, the trip should focus on immersing

travellers in the region’s natural beauty. The trip should include carefully selected eco-paths, accommodations, meals, and transportation, all within the budget.

The experiment took place at the end of September 2024, during which each chatbot provided its solutions. The solutions are presented in their original text form and are available in the online Appendix [Mendeley Data]. Tables 2–5 present the evaluations of the solutions and facilitate a comparison of the chatbots’ performances on these tasks.

The grading criteria were derived from the Related Work section, combining four indices and one metric for service quality assessment: Service Quality Index (SQI), Experience Diversity Index (EDI), Customer Satisfaction Index (CSI), Value for Money (VfM), and Time Efficiency Index (TEI). These five criteria offer a comprehensive evaluation of tourism services, measuring both quality and diversity in the experience. SQI allows for assessing the overall standard of services such as accommodation and meals, which are crucial for customer satisfaction. EDI ensures that itineraries provide a rich, varied experience, blending cultural, historical, and natural attractions. CSI is a direct measure of how likely tourists are to enjoy and recommend the service, reflecting the overall success of the trip. VfM is essential to ensure that travellers feel they are receiving good service for their budget, while the TEI guarantees that the itineraries make the most of the tourist’s time, avoiding wasted hours on travel or poorly planned schedules. Together, these criteria offer a balanced approach to evaluating tourism services from several key perspectives.

The experiment was conducted in late September 2024, during which each chatbot generated its respective solutions. These solutions are presented in their original text form and are available in an online appendix [21]. Tables 2–5 summarize the evaluations and provide a comparison of the chatbots’ performance across the assigned tasks.

The grading criteria were derived from the Related Work section and combined four indices along with one metric for service quality assessment: Service Quality Index (SQI), Experience Diversity Index (EDI), Customer Satisfaction Index (CSI), Value for Money (VfM), and Time Efficiency Index (TEI). These five criteria offer a comprehensive evaluation of tourism services, capturing both quality and the variety of experiences provided.

The SQI assesses the overall standard of services, such as accommodation and meals, which are crucial for customer satisfaction. The EDI ensures that itineraries offer a rich and diverse experience, blending cultural, historical, and natural attractions. The CSI directly measures how likely tourists are to enjoy and recommend the service, providing insight into the trip’s overall success. The VfM evaluates whether travellers perceive that they received adequate value for their budget, and the TEI ensures that itineraries maximize tourists’ time, minimizing inefficiencies such as excessive travel time or poorly organized schedules.

Together, these criteria offer a balanced and multi-dimensional approach to evaluating tourism services, focusing on critical aspects of service quality, experience diversity, customer satisfaction, and overall efficiency.

The evaluation was conducted by two teams who collaboratively assessed the solutions through consensus. The first team consisted of three tourism professionals, while the second comprised four individual tourists. Each chatbot’s grade was determined by consensus after collaborative discussions within each team. The ratings were based on a 5-point scale: 0—fail, 1—below average, 2—satisfactory, 3—good, and 4—excellent.

Table 2. Evaluation of GAI Chatbot Performance by the Tourism Professionals Team: Task #1 Solutions.

Chatbot	SQI	EDI	CSI	VfM	TEI	Total
ChatGPT	3	3	3	3	3	15
Copilot	3	3	3	3	4	16
Gemini	2	4	2	3	2	13
Claude	3	3	3	3	3	15
Perplexity	4	4	4	3	4	19
HuggingChat	3	4	4	3	3	17

The obtained ranking according the tourists experts team is as follows:
Perplexity (19) > HuggingChat (17) > Copilot (16) > ChatGPT (15) ≈ Claude (15) > Gemini (13).

Table 3. Evaluation of GAI Chatbot Performance by the Tourists Team: Task #1 Solutions.

Chatbot	SQI	EDI	CSI	VfM	TEI	Total
ChatGPT	3	3	3	3	3	15
Copilot	3	3	3	3	3	15
Gemini	2	4	3	3	3	15
Claude	2	3	2	2	3	12
Perplexity	4	4	4	4	4	20
HuggingChat	3	4	4	3	3	17

The obtained ranking according the tourists team is as follows:
Perplexity (20) > HuggingChat (17) > ChatGPT (15) ≈ Copilot (15) ≈ Gemini (15) > Claude (12).

From the tourism companies’ viewpoint, ChatGPT’s solution is well balanced in terms of service quality, experience diversity, and time efficiency. It offers a solid combination of activities but does not particularly excel in any one area. From the tourist’s perspective, it provides a satisfactory and comprehensive experience with good value for money, though it does not surpass expectations. Overall, it ranks as a mid-tier option—effective, but not outstanding.

Copilot is strong on time efficiency and value for money due to the well-organized itinerary and thoughtful activity placement from tourist company viewpoint. Tourists will likely appreciate the variety of experiences, though it is a moderate offering overall. It is ranked slightly higher than ChatGPT due to better time efficiency.

Gemini’s experience diversity is excellent with a broader range of locations, but the lower service quality impacts overall satisfaction. Tourists will enjoy the variety but may feel accommodations and services are subpar. This solution is good for budget-conscious tourists but lacks in service quality.

For tourist companies’ representatives, the Claude solution is moderate across the board with no outstanding features. It is a safe option for companies but lacks appeal for tourists. Tourists may find the service quality lacking, especially compared to the other itineraries. It offer relative lower satisfaction for tourists.

Perplexity is top-notch across all criteria, offering excellent service, diverse experiences, and high time efficiency. A premium option that stands out. Tourists will appreciate the high-quality services and experiences, making this the best value-for-money option. It is the best overall option for both companies and tourists, though pricier than others.

HuggingChat solution is high in experience diversity and customer satisfaction, this option offers a good balance between service and costs. Tourists will appreciate the combination of cultural depth and moderate costs. It is strong contender, second only to Perplexity in overall appeal.

Perplexity and HuggingChat are the highest-rated in both tourist companies’ and tourists’ viewpoints. They offer excellent value for money, experience diversity, and customer satisfaction, along with efficient time management. ChatGPT, Copilot and Gemini are fairly well-balanced, with Gemini excelling slightly more in diverse and tourist-friendly experience. Gemini solution has budget-oriented nature, but it remains satisfactory for budget-conscious travellers. Claude provides a good balance but does not excel in any particular area, making it a reliable but average option.

Table 4. Evaluation of GAI Chatbot Performance by the Tourism Professionals Team: Task #2 Solutions.

Chatbot	SQI	EDI	CSI	VFM	TEI	Total
ChatGPT	3	4	4	3	3	17
Copilot	2	3	3	4	3	15
Gemini	3	3	4	3	3	16

Claude	4	4	4	4	3	19
Perplexity	3	3	4	3	3	16
HuggingChat	3	3	3	3	3	15

The obtained ranking according to the tourists experts team is as follows:
Claude (19) > ChatGPT (17) > Gemini (16) ≈ Perplexity (16) > Copilot (15) ≈ HuggingChat (15).

Table 5. Evaluation of GAI Chatbot Performance by the Tourists Team: Task #2 Solutions.

Chatbot	SQI	EDI	CSI	VfM	TEI	Total
ChatGPT	4	4	4	3	4	19
Copilot	3	3	4	4	3	17
Gemini	3	3	4	3	3	16
Claude	4	4	4	4	3	19
Perplexity	4	3	4	3	4	18
HuggingChat	3	3	3	3	3	15

The obtained ranking according to the tourists’ team is as follows:
ChatGPT (19) ≈ Claude (19) > Perplexity (18) > Copilot (17) > Gemini (16) > HuggingChat (15).

ChatGPT solution to Task #2 offers a high level of diversity and a mix of nature, culture, and moderate hiking. Service quality and customer satisfaction are solid, though not optimal in terms of time efficiency due to some long drives. Tourists will likely enjoy the varied experiences, including eco-paths, UNESCO sites, and picturesque views, making it a well-balanced trip with high satisfaction.

Copilot’s solution offers more budget-friendly options, leading to a high “value for money” score. However, the diversity and service quality are slightly lower due to reliance on public transport and simpler activities. For tourists, this is a cost-effective, satisfactory trip with a focus on nature and local culture, but the use of public transport and less diversity may impact the overall experience.

Gemini’s solution is a balanced, straightforward trip and it does not stand out in terms of experience diversity. The service and customer satisfaction are reasonable, but time efficiency could be better. For tourists, it provides a good experience, with cultural visits and some hikes, though it may feel repetitive due to limited variation in activities.

Claude’s solution is the best option for companies, combining eco-friendly tourism with a diverse range of hikes, cultural landmarks, and nature. Excellent value for money due to careful budgeting. Tourists will appreciate the sustainability, range of activities, and seamless organization, resulting in a satisfying and diverse experience.

The solution of Perplexity offers a mix of guided tours and cultural exploration with a strong customer satisfaction rate. However, the costs are slightly higher, impacting “value for money” for both companies and tourists. For tourists, it is a fulfilling trip with scenic hikes and cultural experiences, though they may feel the cost is a bit high compared to alternatives.

HuggingChat offer is budget-friendly and provides decent service, though experience diversity is slightly limited compared to others. It is a straightforward option with moderate customer satisfaction. Tourists may find this trip simple and enjoyable, but without the variety and richer experiences found in other solutions.

Claude’s solution stands out as the top choice, balancing sustainability, value, and diversity, making it appealing for both tourists and tour operators. Copilot offers great value for money, though experience diversity is lower. ChatGPT and Perplexity offer a nice blend of culture and nature, but may be a bit more expensive for tourists.

Based on the obtained results, it can be concluded that GAI chatbots hold potential as a valuable tool for digitizing both the business processes of tourism companies and tourist activities, as they demonstrated a reasonable level of success. The selected six GAI chatbots successfully addressed both

tasks—Task #1 and Task #2. Overall, ChatGPT, Claude, and Perplexity exhibited the highest performance, achieving total scores of 36 for Task #2, 38 for Task #2, and 39 for Task #1 respectively out of 40 points maximum. In contrast, Gemini received the lowest score, with 28 out of 40 points for Task #1. This ranking aligns with expectations, given that ChatGPT and Perplexity are built on the GPT-4 LLM, as described in Section 2.2.

The results demonstrate that GAI chatbots effectively support travel planning for both organized tourist groups and individual travellers. The chatbots generated unique and diverse suggestions that align with user-specific requirements. Our findings are consistent with previous research, highlighting that next-generation chatbots significantly enhance digital tourism by prompting users to explore destinations more thoroughly and make informed decisions. For instance, studies by Zhang et al. [19] and Volchek and Ivanov [20] compared the outcomes of GAI chatbots with those of human tourism professionals, indirectly assessing chatbot effectiveness. Our study takes a broader approach, evaluating the readiness of chatbots to assist both tourism companies and individual travellers.

However, despite their solid performance, human oversight remains essential to verify the accuracy, consistency, and feasibility of chatbot-generated solutions, particularly when dealing with more complex tasks. GAI chatbots face limitations in addressing intricate problems, which may lead tourism stakeholders to hesitate in fully relying on them. To optimize their use, employees and managers in tourism companies should familiarize themselves with the capabilities of GAI chatbots in advance and recommend the most suitable chatbot based on specific activities and destinations.

6. Conclusions and Future Research Directions

In this paper, we present a novel theoretical framework for implementing and evaluating the effects of GAI tools on travel companies and individual tourists. By integrating various GAI instruments, the framework provides a holistic approach that assists tourism companies in incorporating advanced technologies into their business models, thereby facilitating a smoother digital transition in their services. The proposed framework not only benefits travel companies by streamlining operations but also empowers tourists through personalized recommendations and easy access to information, enhancing their travel planning experience and leading to more satisfying and memorable journeys.

We applied this new framework for GAI-assisted tourism to study the impact of GAI chatbots on two types of trip planning: one international and one domestic, each under specified budget constraints. Unfortunately, the evaluation of GAI chatbots' capabilities as trip planning tools yielded mixed results. In both tasks—Task #1 for the international trip and Task #2 for the domestic trip—three out of six GAI chatbots (ChatGPT, Claude, and Perplexity) performed exceptionally well. Specifically, they achieved 90.0% and 95.0% of the maximum possible points for Task #2 and 97.5% for Task #1, respectively.

The following recommendations are provided for tourism companies and tourists using the proposed GAI-assisted travel framework. Travel companies—such as tour operators and travel agents—should develop a robust strategy for GAI adoption. This strategy should include plans for investing in cutting-edge information technologies, as well as improving the digital and AI proficiency of managers and employees. The delay in digital transformation, particularly within the tourism sector, poses significant challenges. According to the most recent Digital Economy and Society Index (DESI) report on digital competitiveness in EU Member States [22], only 38.90% of enterprises utilize cloud computing, 14.22% use big data, and a mere 8.00% implement artificial intelligence (AI), significantly falling short of the EU 2030 targets of 75% for each technology. Addressing these gaps in the tourism industry requires a strategic focus on long-term training programs that improve AI literacy, data analytics, technical skills, customer service, adaptability, and ethical considerations related to digital innovation.

Local, regional, and national tourism bodies can also benefit from GAI and the proposed framework by developing and promoting sustainable tourism practices. This could involve analysing environmental data and traveller behaviour to generate content that educates tourists on sustainable

practices or creating tools to help travellers make eco-friendly choices. During crises, such as natural disasters or pandemics, GAI can facilitate the rapid dissemination of accurate information to tourists, helping manage communication effectively and maintaining trust with visitors. By leveraging these capabilities, tourism authorities can optimize their operations, enhance visitor satisfaction, and bolster their competitive position in the global tourism market.

This study, however, has several limitations: 1) some steps in the proposed framework were not fully tested, such as real-time experiments with GAI tools during travel; 2) the reliability of GAI chatbots as travel planning tools was evaluated by only two small teams of respondents, which limits the generalizability of the findings; 3) the analysis of expert and tourist assessments did not consider changes over time, due to a lack of prior data; and 4) the relationships between tourist satisfaction, travel company performance, and the degree of GAI integration were not explored.

Our future research will focus on: 1) collecting and analysing data on customer satisfaction and attitudes towards GAI-assisted travel; 2) conducting comparative studies between our findings and similar research in other countries, considering customer characteristics such as age, gender, education, and travel experience; and 3) monitoring advancements in GAI-based travel technologies and reviewing their impact on the business models of tourism companies.

Author Contributions: Conceptualization, G.I. and T.Y.; modelling, G.I., T.Y., and S.K.-B.; validation, G.I. and T.Y.; formal analysis, T.Y.; resources, G.I., T.Y., and S.K.-B.; writing—original draft preparation, G.I.; writing—review and editing, G.I., and T.Y.; visualization, T.Y. and S.K.-B.; supervision, G.I.; project administration, G.I.; funding acquisition, G.I., T.Y., and S.K.-B. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Research Program “Young Scientists and Post-Doctoral Researchers-2” (YSPDR-2), and the National Science Fund, co-founded by the European Regional Development Fund, Grant No. BG05M2OP001-1.002-0002 “Digitization of the Economy in Big Data Environment”.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data stored as pdf file are publicly available at <https://data.mendeley.com/drafts/xs322m3cgb> (accessed on 30 September 2024).

Acknowledgments: The authors thank the academic editor and anonymous reviewers for their insightful comments and suggestions.

Conflicts of Interest: The authors declare no conflicts of interest.

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