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AI Chatbots in Culinary Ecotourism Based on Zero-Waste Gastronomy to Support Green Tourism

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ABSTRACT

Sustainable tourism requires a balance between human activities and environmental conservation. One strategy that can support this goal is the implementation of zero-waste gastronomy in the ecotourism culinary industry. However, its implementation still faces serious challenges, such as low tourist awareness of the impact of food consumption, a lack of education regarding food ingredients and carbon footprints, and limited digital infrastructure. The purpose of this study is to develop and test the effectiveness of AI chatbots as virtual assistants in zero-waste-based culinary ecotourism to increase tourist awareness while supporting restaurant operational efficiency. The research methods used include literature studies, interviews with four in-depth sources with four sources who are MSME and restaurant managers who have implemented zero-waste gastronomy principles. Data were analyzed using a descriptive qualitative approach for the interviews, as well as simple quantitative analysis from observations to determine the level of tourists' understanding and interest in zero-waste practices. The results of the study show that tourists are highly enthusiastic about the concept of sustainable cuisine, but their knowledge is still limited. The AI chatbots developed have proven capable of presenting interactive information about menus, food ingredients, and zero-waste practices in an interesting and easy-to-understand manner. This discussion confirms that this technology not only strengthens tourist awareness, but also plays a role in improving communication and education efficiency for ecotourism restaurants. In conclusion, the development of AI chatbots for zero-waste cuisine has the potential to shape a more efficient, environmentally friendly ecotourism ecosystem and contribute significantly to reducing food waste globally.

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1. INTRODUCTION

Green tourism is a primary solution to address the challenges of climate change and increasing environmental degradation. This approach focuses on developing sustainable, environmentally friendly tourism that does not damage tourist sites and cultural heritage, in line with the views expressed by Arismayanti (2015). In this regard, culinary ecotourism plays a significant role because it not only provides a unique gastronomic experience but also contributes to sustainability through the implementation of zero-waste gastronomy (Suroto & Hermawati, 2023). This concept emphasizes the optimal use of food ingredients, waste reduction, and the application of more environmentally friendly cooking and serving techniques.

The application of zero-waste principles in the tourism industry can be an innovative solution for managing waste and supporting sustainable tourism goals (Satriawati et al., 2024). The increasing awareness of tourists regarding sustainability issues provides a great opportunity for destinations that adopt the zero-waste principle to attract visitors who care about the environment, where a strong gastronomic identity can create a more sustainable tourism experience (Kusuma, 2021). Amid rapid digital transformation, the implementation of artificial intelligence (AI) chatbots in zero-waste culinary ecotourism is an innovative step that is urgently needed, as suggested by Siddik et al., (2025).

AI chatbots can educate tourists about the importance of sustainable consumption, provide recommendations for restaurants that implement zero-waste principles, and optimize the tourist experience through interactive services based on artificial intelligence (Patel, 2023). This technology also has the potential to reduce dependence on human labor, improve operational efficiency, and expand the reach of information related to sustainable culinary practices (Nur et al., 2025). However, the implementation of AI Chatbots in culinary ecotourism faces several challenges, such as limited technological infrastructure in some tourist destinations, a lack of understanding among business operators about AI integration, and resistance from tourists to the use of technology in their travel experiences culinary brand (Rafiq, F et al.,, 2022).

If these challenges are not addressed immediately, then the great opportunity to optimize the sustainability of green tourism could be missed. Therefore, this research is crucial to explore how AI chatbots can be effectively applied to support the concept of Zero-Waste Gastronomy and accelerate the transformation of culinary ecotourism towards sustainability (Gabriel & Cosmin, 2024), while monitoring and managing tourism activities to reduce environmental impact. This research is particularly urgent, given the high volume of food waste, the lack of tourist education, and the great potential for applying AI chatbots to improve the efficiency and sustainability of the culinary sector, which could ultimately create a more educational, efficient, and environmentally friendly technology-based ecotourism culinary ecotourism ecosystem.

This is in line with the opinion of (Setiawan & Cakrawala, 2024) which states that chatbots can encourage sustainable eating habits and reduce food waste through advanced technology. However, in the effort to realize sustainable tourism, the implementation of zero-waste gastronomy in the ecotourism culinary industry still faces various major challenges. Low tourist awareness of the environmental impact of food consumption, limited education about food ingredients and carbon footprints, and inadequate supporting digital infrastructure support are the main obstacles. According to the 2021 Food Waste Index Report, the culinary sector generates nearly 931 million tons of food waste annually worldwide, exacerbating carbon emissions and pressure on natural resources.

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If this issue is not addressed seriously, efforts to achieve sustainable tourism will become increasingly difficult, especially within the framework of ecotourism, which prioritizes a balance between human activities and environmental conservation. Many culinary businesses do not yet have an educational system in place to inform visitors about environmentally friendly practices (Irawan, 2023). The application of artificial intelligence can help overcome this challenge by increasing awareness and operational efficiency through more environmentally friendly digital technologies, including the application of predictive analytics to minimize waste (Clark et al., 2024).

In this context, AI can also be used to design a more sustainable customer experience by providing real-time information about the ingredients used and their environmental impact (Dewi & Fauzzia, 2023). In addition, the development of AI-based systems in tourism management can improve restaurants' ability to reduce food waste and optimize the use of raw materials more efficiently (Budianto, S., 2025). In line with this, although the culinary sector has significant potential to reduce food waste, many culinary businesses in Indonesia still lack the resources and knowledge to effectively implement zero-waste principles. Better education and awareness about sustainability in the culinary sector are essential to achieve this goal (Gardjito, M. et al., 2019).

This book also emphasizes the importance of collaboration between industry players stakeholders and technology to implement a more integrated zero-waste strategy in every aspect of restaurant operations. In addition, technology-based systems that support direct communication with customers can be an effective means of spreading environmentally friendly practices among visitors (Anggoro & Akbar, 2023).

The following presents the research problem formulation:

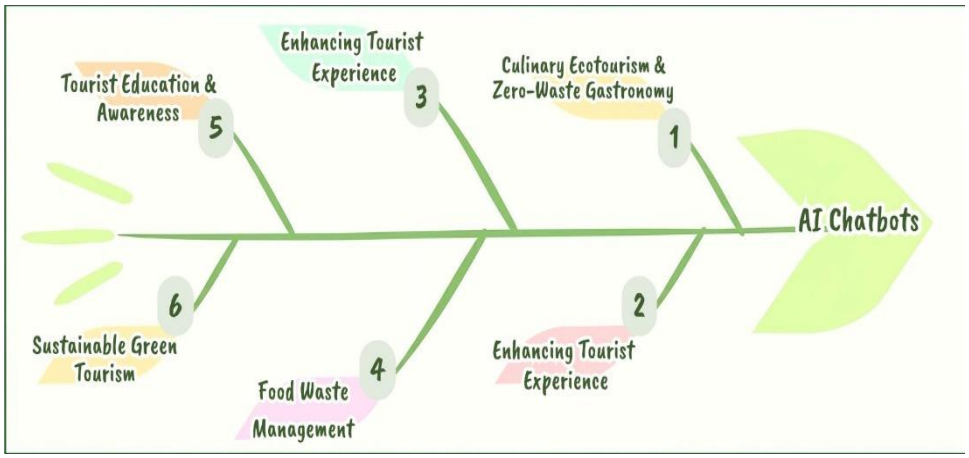

Figure 1. Research Questions

Source: Data processed by the researchers

This study focuses on the application of AI Chatbots in culinary ecotourism based on zero-waste gastronomy to support the sustainability and efficiency of restaurants. The main problems found are the lack of education about zero-waste gastronomy and the limitations of technology application in the sustainable culinary sector. Although some restaurants have adopted the zero-waste concept, many find it difficult to educate tourists about food waste management. Cahyadi, H. S., (2019) emphasizes the importance of innovation in tourism management to create a positive impact, while Hendratman (2018) shows how technology can improve communication with customers. AI Chatbots has a great potential to reduce food waste and provide more efficient education. Wachyuni, S. S., (2023) also highlights sustainable cuisine as a tourist attraction that supports sustainability.

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2. LITERATURE REVIEW

2.1. AI Chatbots in the Tourism Industry

2.1.1. Definition and Concept of Artificial Intelligence (AI)

Artificial Intelligence (AI) refers to the ability of machines or computers to mimic human thinking and intelligence in performing certain tasks, such as learning, problem-solving, decision-making, and natural language understanding. The use of AI covers various sectors, including tourism, to improve customer experience, operational efficiency, and service personalization (Sejera, S. G., Bocarnea, 2022).

AI is applied in many sectors such as healthcare, automotive, finance, and tourism. In the context of tourism, AI is used to provide travel recommendations, predict tourism trends, and manage inventory and reservations automatically (Gretzel, et.al, 2015). AI also helps in analyzing big data to understand tourist behavior and preferences, which are then used to create a more personalized and environmentally friendly travel experience.

One of the most common forms of AI implementation in the tourism industry is AI chatbots. AI-based chatbots are used to interact with tourists via text or voice messages, providing information about destinations, simplifying the booking process, and providing recommendations tailored to tourist preferences (Shawar, B. A., & Atwell, 2007) These chatbots can also help tourists plan more efficient and environmentally friendly trips.

2.1.2. The Role of AI Chatbots in Tourism

AI chatbots play a major role in improving the operational efficiency of tourism services by automating various processes that previously required direct interaction with humans, such as answering questions, processing orders, and providing recommendations. This increases response speed, reduces waiting times, and optimizes the customer experience (Buhalis, D., Law, 2008). Chatbots are used in various aspects of tourism to simplify the travel process for tourists. For example, chatbots can provide information about tourist destinations, such as places of interest, operating hours, and recommended activities. They also assist in the process of booking hotels or tickets, provide updates on booking status, or offer special deals. In addition, chatbots also provide customer service by answering frequently asked questions, resolving complaints, or providing technical assistance when travelers encounter problems.

The role of chatbots in improving service efficiency and sustainability in the culinary industry. One approach that has been developed is a simple-reflex agent-based chatbot, which allows tourists to interact using everyday language to obtain information in a faster and more efficient manner (Rahayu et al., 2020). In the context of sustainable tourism, AI chatbots can provide information that supports environmentally friendly decisions, such as recommending public transportation or accommodations that prioritize sustainability. Chatbots can also play a role in educating tourists about the importance of sustainability and more efficient resource management, which contributes to reducing carbon footprints and preserving nature (Tussyadiah, 2020).

2.1.3. AI in Sustainable Tourism

Sustainable tourism prioritizes environmental, social, and cultural preservation, aiming to reduce negative impacts on the environment and ensure long-term benefits for local communities and ecosystems (Canton, 2021). In this case, AI plays a role in planning more environmentally friendly trips, such as suggesting sustainable transportation and accommodations that have sustainability certifications. In addition, AI can support more efficient resource management, reduce energy and water waste, and maximize the use of

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food ingredients in restaurants (Gretzel, U et al.,2015).

AI has been applied to manage and reduce food waste through an AI-based system capable of monitoring and analyzing food consumption in real-time, which can be adapted to culinary ecotourism (Clark et al., 2024). AI has also been widely used in tourism services, such as virtual tours, AI-based recommendations, and service management, which are important references in the development of chatbots to enhance the tourist experience in culinary ecotourism (Irawan, 2023). The use of AI in creating smarter, safer, and more personalized travel experiences further strengthens the relevance of chatbots in supporting sustainable culinary practices (Setiawan & Cakrawala, 2024).

2.2. Culinary Ecotourism

2.2.1. Definition of Culinary Ecotourism

Culinary ecotourism is a form of tourism that combines the experience of enjoying local cuisine with efforts to preserve the environment and local culture. This approach aims not only to provide an in-depth culinary experience, but also to support sustainability by promoting the use of local, organic, and environmentally friendly ingredients (Horner, S., Swarbrooke, 2004). Culinary ecotourism also educates tourists about culinary diversity and its contribution to the preservation of local nature and culture (Mandić, A., Walia, 2023). While culinary tourism generally focuses only on the dining experience, culinary ecotourism prioritizes sustainability in every aspect of the culinary experience, including waste management and support for local agriculture (Hall, C. M., Gössling, S., Scott, 2015).

In culinary ecotourism, tourists not only enjoy food, but also understand how it is produced in a way that respects nature and culture. Culinary ecotourism also emphasizes strong cultural values, involving tourists in the process of understanding and appreciating local culinary traditions, which reflect the cultural heritage of a community. The practice of using local and seasonal ingredients, as well as supporting environmentally friendly agriculture, plays an important role in maintaining ecosystem balance and promoting environmental awareness (Shasha, Z. T et al., 2020).

2.2.2. Principles of Culinary Ecotourism

Culinary ecotourism emphasizes sustainability in every culinary activity, from the selection of food ingredients to the way they are served. One of its main principles is the use of local and organic ingredients to support sustainable agriculture and reduce the carbon footprint caused by food transportation (Jones, C. R., Walmsley, 2022) In addition, this principle also promotes the consumption of fresher and healthier seasonal foods, while introducing tourists to the diversity of local cuisine. Culinary ecotourism has a significant impact on the local economy by supporting local products and small businesses. It also plays a role in preserving culinary culture, which is often threatened by cultural homogenization due to globalization (Chauhan, A et al., 2026). Thus, culinary ecotourism not only creates economic opportunities but also preserves local cultural identity.

2.2.3. Technology in Culinary Ecotourism

Technology, including artificial intelligence (AI), is increasingly being used to enrich the culinary experience of tourists. This technology allows tourists to find food options that are relevant to their preferences, including locally sourced and organic foods (Tussyadiah, 2020). In addition, technologies such as AI chatbots enable restaurants to provide faster and more efficient service, as well as suggest culinary options that are more environmentally friendly and in line with sustainability principles. AI chatbots can recommend restaurants that

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prioritize the use of local and organic ingredients, as well as those with efficient waste management practices or sustainability certifications. This enables travelers to make more environmentally responsible choices while ensuring they have an authentic culinary experience aligned with sustainability values (Gretzel, U et al.,2015).

2.3. Theoretical Framework: Zero-Waste Gastronomy

2.3.1. Definition of Zero-Waste Gastronomy

Zero-waste gastronomy is an approach in the culinary industry that focuses on reducing food waste to zero by maximizing the use of every part of the available ingredients. This approach is important for creating a more sustainable and environmentally friendly food system, reducing the impact of carbon emissions and resource waste. One of the main principles of zero-waste gastronomy is the utilization of all parts of food ingredients, such as peels, stems, and leaves, which are usually discarded (Sachs, 2020). This approach also emphasizes efficient kitchen waste management, such as recycling or composting food scraps. Some strategies to reduce waste in the kitchen include careful menu planning, using seasonal and local ingredients, and more efficient stock management (Hall, C. M., Gössling, S., & Scott, 2015). Technology can also play a big role in predicting the amount of ingredients needed and avoiding excessive purchases that often end up being wasted.

2.3.2. Zero-Waste Practices in the Culinary Industry

In zero-waste practices, various techniques such as upcycling, fermentation, drying, and utilizing ingredients that are often considered useless, such as stems or leaves, are used to increase menu diversity and create new flavors (Yang, D., Wang, A. X., Zhou, K. Z., & Jiang, 2019). These techniques help reduce waste while increasing the nutritional value of the food served to consumers.

Technology plays an important role in optimizing restaurant operations towards zero waste. AI-based inventory management systems can help predict ingredient needs more accurately and avoid over-purchasing. Food waste monitoring applications such as Winnow Solutions enable restaurants to analyze and reduce food waste in real time (Herrero, M et al., 2020). This technology supports more sustainable and environmentally friendly culinary practices. The implementation of the zero-waste concept in the tourism sector has also been studied, taking into account community participation, waste management systems, environmentally friendly technological innovations, and partnership models that can support the sustainability of the culinary industry (Satriawati et al., 2024).

2.3.3. Challenges and Solutions in Implementing Zero-Waste Gastronomy

The main challenges in implementing zero-waste are the high initial costs for the necessary equipment and infrastructure. Restaurants also face difficulties in training staff to support zero-waste principles, as well as limited availability of local raw materials (Jones, P., Hillier, D., Comfort, 2016) In addition, low consumer awareness of the importance of zero-waste practices can be an obstacle to implementation.

AI-based technologies, such as kitchen management systems and waste monitoring applications, can provide significant solutions. These systems can predict ingredient demand more accurately and identify sources of food waste for better reduction strategies. In addition, educational applications and digital campaigns can help raise consumer awareness about the benefits of zero waste practices in the culinary industry.

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2.4. Theoretical Foundation: Green Tourism

2.4.1. Definition and Concept of Green Tourism

Green tourism refers to a form of tourism that emphasizes sustainability, aims to minimize negative impacts on the environment, and supports the preservation of local culture. This approach aims to create a tourism experience that is in harmony with nature, while strengthening awareness of the importance of environmental conservation (Sharpley, 2009). In green tourism, tourist destinations prioritize the responsible and sustainable management of natural resources, such as reducing the use of plastic, improving waste management efficiency, and optimizing energy use.

Green tourism destinations have several key characteristics, including the application of strong nature conservation principles, such as the protection of flora, fauna, and natural habitats. Local communities also play a key role in destination management, which aims to maintain a balance between culture and the environment (Saarinen, 2021).

2.4.2. Green Tourism Practices

Sustainable tourism practices in tourist destinations focus on responsible management to reduce negative impacts on the environment and local culture. This includes reducing carbon footprints by choosing environmentally friendly transportation, using renewable energy, and efficient waste management (Canton, 2021). In addition, educational programs that teach tourists about environmental and cultural preservation are also part of more environmentally friendly sustainable tourism efforts.

Green tourism practices also bring economic benefits to local communities by creating sustainable jobs, raising awareness of the importance of sustainability, and promoting a conservation-based local economy (Ullah, Z et al.,2021). Through the more efficient management of natural resources, green tourism ensures long-term benefits for local communities and strengthens nature conservation efforts.

2.4.3. Technology Integration in Green Tourism

Technology, especially AI, plays an important role in supporting green tourism practices. AI helps process big data to identify trends, plan more efficient trips, and provide travelers with recommendations on environmentally friendly options. For example, AI-based chatbots can suggest eco-friendly destinations, activities that do not harm nature, and accommodations that prioritize sustainability (Gretzel, U et al., 2015). Thus, this technology enables travelers to make smarter and more environmentally responsible decisions. AI can also guide travelers to choose green transportation, such as trains or electric buses, and select sustainable accommodations that reduce their carbon footprint through the use of renewable energy and effective waste management policies (Tussyadiah, 2020).

2.5. Integration of AI Chatbots in Zero-Waste Gastronomy-Based Culinary Ecotourism for Green Tourism

2.5.1. The Concept of Technology and Sustainability Integration in Tourism

Technology, particularly AI chatbots, is increasingly being used to support sustainability in the tourism and culinary sectors. AI-based chatbots can provide tourists with relevant information about eco-friendly destinations, accommodations that support nature environmental conservation, and activities that have minimal impact on the environment. In the culinary sector, chatbots can recommend restaurants that prioritize local, organic, and environmentally friendly ingredients, as well as menus that adhere to zero-waste principles

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(Gretzel, U et al.,, 2015) With this information, technology helps tourists make more sustainable decisions, both in choosing destinations and in their food consumption.

AI chatbots also facilitate a more environmentally friendly travel experience by directing tourists to green transportation options, such as public transportation or bicycles, and providing information about accommodations that implement sustainability principles. In the culinary sector, chatbots can help implement zero-waste practices by recommending restaurants that manage food waste efficiently and educating customers about the importance of reducing food waste (Shawar, B. A., Atwell, 2007).

Chatbot frameworks such as Rasa have been developed in various sectors, including the culinary and tourism industries, proving their flexibility and potential for implementation in enhancing tourist interaction with culinary ecotourism services (Anindyati, 2023). Natural language processing-based chatbots have also been applied to recommend food based on users' calorie needs, which can be adapted in a zero-waste context to educate tourists about more sustainable food consumption (Anggoro & Akbar, 2023). In terms of education, chatbots have also been utilized as an interactive medium in learning, which is relevant in providing tourists with an understanding of sustainable culinary practices (Ardiansyah, 2023).

2.5.2. Benefits of AI Chatbot Integration in Culinary Ecotourism and Zero-Waste Gastronomy

The integration of AI chatbots provides significant benefits for tourists by providing more personalized and relevant information according to their preferences, especially regarding environmentally friendly culinary options. For example, chatbots can recommend restaurants that use local and organic ingredients and support sustainable practices such as proper waste management or menus with minimal waste (Buhalis, D., Law, 2008). With easily accessible information, tourists can make more environmentally conscious choices about their culinary consumption.

For those in the culinary and tourism industries, the use of AI chatbots also increases operational efficiency by automating tasks such as providing information and processing orders. This reduces the operational costs of restaurants and tourism service providers, while also reducing waste through more efficient data-driven advice on food and resource management (Herrero, M et al., 2020). In the green tourism sector, AI chatbots can support environmentally friendly initiatives by directing tourists to sustainability-focused activities and promoting transportation and accommodation options that reduce carbon footprints (Gretzel, U et al.,, 2015).

In line with the zero-waste principle, previous research has also developed a mobile application that helps the community reduce food waste and share food with those in need, which can be integrated with chatbots in reservation systems or sustainable food recommendations (Khosyiati, E. et al., 2023). Furthermore, chatbots have been proven to improve customer experience through quick responses and personalized interactions in the culinary sector, which can help increase tourist satisfaction in zero-waste-based culinary ecotourism (Sari, 2024). Chatbots also have a positive impact on customer satisfaction and service improvement (Setiarini, 2025) in the culinary tourism industry as a whole, making them an innovative solution in supporting sustainable green tourism initiatives (Lianto, R, 2024).

As an example of technology application, restaurants such as Nolla in Helsinki, which focuses on a zero-waste menu, can use AI to provide information about the ingredients used and how they reduce food waste. Tourist destinations such as Costa Rica have also integrated technology to suggest activities that support sustainability, such as culinary tours that prioritize organic ingredients and minimize carbon footprints (Honey, 1999).

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3. METHODS

This study applies a descriptive qualitative method, as described by Sugiyono (2022), with the aim of analyzing and describing a phenomenon in depth through qualitative data, such as interviews, observations, and documentation. The main focus of this research is to provide a comprehensive overview of the application of AI chatbots in culinary ecotourism based on zero-waste gastronomy as a support for green tourism. The approach used is also in line with the method applied by Sugiyono (2014), as follows:

a. Interviews

Interviews were used as a data collection method when researchers conducted a preliminary studies to identify issues that needed to be researched, as well as to gain deeper insights from respondents regarding issues in the application of AI chatbots in zero-waste gastronomy-based culinary ecotourism to support sustainability. Interviews were conducted by researchers with sources ParaSehat (Mr. Azmi), Warung 1000 Kebun (Mr. Ali), Sugu Resto (Mr. Pauzi) and Green and Beans (Mr. Deden)

b. Observation

"Observation is a complex process, consisting of various biological and psychological processes." Observation in this study is a data collection method conducted by observing, studying, or measuring ongoing events, then documenting the conditions that occur in the field. The observation location focused on MSME and restaurant managers who have implemented the principles of zero-waste gastronomy.

c. Documents

A questionnaire or survey is a data collection technique conducted by providing a series of written questions and statements related to the variables and dimensions being studied to be answered by respondents. Researchers collect data by asking questions in writing and selecting the population and sample for the questionnaire, which aims to obtain respondents' responses regarding the use of AI chatbots in zero-waste gastronomy-based culinary ecotourism to support green tourism.

The research process was first designed using a flowchart as a guide for each stage to ensure accurate and structured results. The research flowchart shown in Figure 3 summarizes all the stages required in the application of AI chatbots in culinary ecotourism based on zero-waste gastronomy to support green tourism.

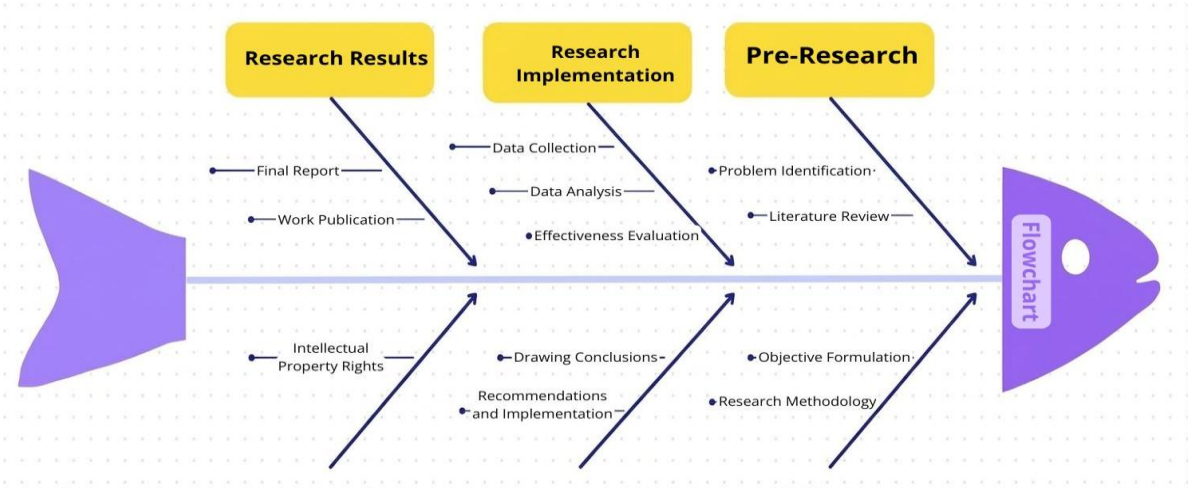

Figure 2. Research Flowchart
Source: Data processed by researchers

Research flowchart summarizing all stages required in the application of AI chatbots in culinary ecotourism based on zero-waste gastronomy to support green tourism. The

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identification of problems in this study points to a lack of education related to zero-waste gastronomy in culinary ecotourism and the suboptimal integration of AI chatbots to support green tourism (Rahmadewi, YM, Ayuningtyas, CE, & Susianti 2024). This problem forms the basis for determining the direction of the research, with the aim of producing a clear and relevant problem formulation for culinary ecotourism, as well as achievements that demonstrate the suitability of the problem to the needs of industry and academia. Furthermore, a literature review was conducted to analyze previous research on AI in the tourism sector and the concept of zero-waste gastronomy.

The objective of this stage is to build a strong theoretical foundation for this research, with the results being credible and up-to-date references, as well as outputs in the form of literature sources from journals or studies that are recognized in their field. The formulation of research objectives aims to determine the role of AI chatbots in enhancing the sustainability of zero-waste culinary ecotourism (Prabowo, E and Widagdyo, K.G, 2023). The output of this stage is a clear and testable research objective, with achievement indicators in the form of the alignment of the research objective with the identified problems and the reviewed literature.

In the next stage, research methods and instruments include the selection of data collection methods such as interviews, observation, and documentation, as well as the determination of research locations and key informants such as restaurant owners, tourists, and tourism managers, used to ensure that the data obtained are representative (Yusra, RZ. Zulkarnain, 2021). The output of this stage is a systematic and applicable research method design, with achievement indicators in the form of research instruments that are ready to be used for data collection.

Data collection was conducted using three main methods: observation to observe the implementation of zero-waste gastronomy, interviews with restaurant managers, tourists, and AI experts to gain in-depth insights into the effectiveness of AI chatbots, and documentation from relevant policies, reports, and studies (Romdona, S., *et al,* 2025). The result is accurate data that reflects real-world conditions, with achievement indicators in the form of verifiable data and strong relevance to the research objectives.

Data analysis was conducted in three stages: data reduction to select relevant information, data presentation in the form of descriptions, tables, or graphs, and data interpretation to relate the findings to the analyzed theory (Agama, IP. DI, 2022). The output of this stage is an analysis that can identify patterns and trends in the application of AI Chatbots in culinary ecotourism, with achievement indicators in the form of logical conclusions based on the data obtained. The effectiveness of AI chatbots is evaluated to assess how effective chatbots are in increasing tourists' understanding of zero-waste practices and their impact on the operational efficiency of zero-waste restaurants.

The result is a model for implementing AI chatbots in culinary ecotourism based on zero-waste gastronomy, with the achievement indicator being a model that can be applied to support the sustainability of the green culinary industry. Conclusions were drawn regarding the role of AI chatbots in supporting the sustainability of culinary ecotourism, both in terms of education, waste management, and tourist experience. The output of this stage is a conclusion that can serve as a basis for further development, with achievement indicators in the form of the alignment of the conclusion with the research objectives and its potential in supporting innovation in the green tourism sector.

Further recommendations and implementation include the development of more interactive and intelligent AI Chatbots (Sakti, M.E.S and H. S. P., 2024), as well as the integration of chatbots with restaurant management systems and green tourism applications. The outcome of this stage is practical and useful recommendations for stakeholders, with

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achievement indicators in the form of recommendations that can be implemented by the industry and have long-term sustainability value. Finally, a research report documenting all research results will be compiled in the form of an academic report, scientific publications, and intellectual property rights, which can be used by academics and practitioners, with achievement indicators in the form of well-structured reports and scientific publications in Sinta 3 journals.

4. RESULTS AND DISCUSSION

This study aims to develop and implement AI chatbots in culinary ecotourism based on zero-waste gastronomy to support the sustainability of green tourism. The expected results include the development of a chatbot model capable of educating tourists about zero-waste practices and improving the operational efficiency of environmentally friendly restaurants. In addition, this study aims to increase tourist awareness and participation in the implementation of green tourism, while also compiling recommendations for AI implementation strategies in the ecotourism industry and exploring the contribution of AI Chatbots in improving tourist understanding and restaurant operational efficiency in managing food ingredients sustainably. During the data collection stage, interviews were conducted with sources from ParaSehat (Mr. Azmi), Warung 1000 Kebun (Mr. Ali), Sugu Resto (Mr. Pauzi), and Green and Beans (Mr. Deden), who focus on sustainability studies and zero-waste gastronomy, as well as MSME managers and restaurants that have implemented the principles of zero-waste gastronomy. Observations were also conducted to assess the implementation of zero-waste principles and related policy documentation. The data obtained showed varying levels of tourist awareness regarding the concept of zero-waste gastronomy, as reflected in the following interview results:

Table 1. Tourist Awareness of Zero-Waste Gastronomy

SMEs/Restaurants	Tourist Awareness of Zero-Waste	Educational Approach
ParaSehat	Increasing, especially among tourists who care about sustainability	Social media, bazaars, workshops, and direct outreach
Sugu Resto	Increasing, although there is still a negative stigma attached to "waste" materials	Education through social media and direct communication
Green and Beans	Increasing, many tourists are looking for environmentally friendly culinary options	Education in restaurants, social media, and direct explanations about sustainability
Warung 1000 Kebun	Increasingly, many tourists care about sustainability	Social media, direct communication, and education about environmentally friendly ingredients

Source: Data processed by researchers

Based on the interview results shown in the table, tourist awareness of Zero-Waste in various restaurants has shown a significant increase. Restaurants such as Para Sehat, Sugu Resto, Green and Beans, and Warung 1000 Kebun reported that tourists are increasingly concerned about sustainability and environmentally friendly culinary choices. Although there is a negative stigma associated with waste, especially at Sugu Resto, overall, this trend of awareness is growing. In terms of educational approaches, each restaurant has different ways of conveying information about Zero-Waste. Education is conducted through various

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channels, such as social media, bazaars, workshops, and direct explanations to visitors. This approach aims to introduce the importance of sustainability and Zero-Waste, thereby encouraging tourists to be more concerned about the environmental impact of their choices, as supported by Vuksanović, N et al., (2024).

Table 2. Comparison of Food Waste Reduction in Restaurants Using AI Chatbots

Restaurant	Use of AI Chatbot	Impact on Food Waste
Para Sehat	Not yet implemented, but there are plans to use a digital platform for ordering	Potential to reduce raw material waste with sustainable menu recommendations
Sugu Resto	Not yet implemented	Potential to reduce raw material waste with a more efficient ordering system
Green and Beans	Not yet implemented	Potential to reduce waste with menu recommendations based on customer preferences
Warung 1000 Kebun	Not yet implemented, but there are plans for the future	Potential to reduce waste with eco-friendly menu suggestions via chatbot

Source: Data processed by researchers

Based on the results of the table, it can be concluded that the four restaurants listed have not yet implemented the use of AI Chatbots, although some restaurants have plans to implement them in the future (Altamimi, I *et al*., 2023). However, all restaurants show the potential for using this technology to reduce food waste. This potential includes sustainable and environmentally friendly menu recommendations that can help reduce raw material waste and food waste. In addition, a more efficient ordering system can also help optimize the use of raw materials, which in turn contributes to reducing food waste.

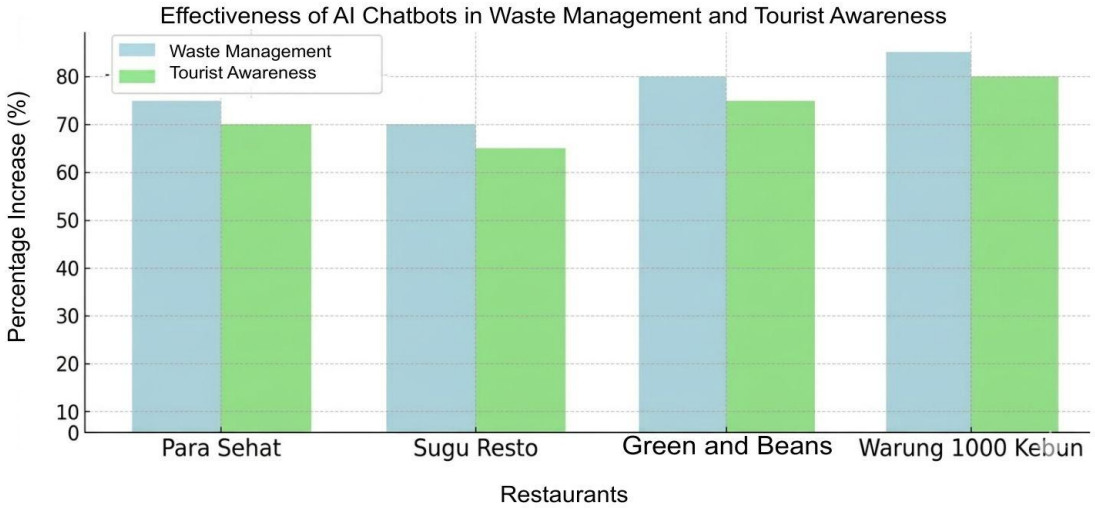

Figure 2. Effectiveness of Chatbots in Improving Waste Management and Tourist Awareness
Source: Data processed by researchers

Based on the graph, it can be concluded that AI chatbots are effective in improving waste management and tourist awareness in all restaurants tested. Each restaurant showed a significant increase in both aspects, with almost equal levels of improvement in waste management (blue) and tourist awareness (green). Overall, AI chatbots play an important role

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in promoting environmental awareness and better waste management in the restaurant sector (Mei, C. W., Konar, R., & Kumar, 2024).

Table 3. Chatbot Development Recommendations

Restaurant	Chatbot Development Recommendations
ParaSehat	Implementation of a chatbot to provide ongoing menu information and waste education
Sugu Resto	Using chatbots to improve ordering efficiency and sustainability education
Green and Beans	Use of chatbots for eco-friendly menu recommendations and waste reduction
Warung 1000 Kebun	Development of chatbots to provide education on waste reduction

Source: Data processed by researchers

Based on the recommendations for chatbot development in each restaurant, it can be concluded that all restaurants focus on using chatbots to support sustainability and waste management (Baloglu, S., Raab, C., & Malek, 2020). Para Sehat suggests implementing chatbots to provide information on sustainable menus and educate customers about waste. Sugu Resto focuses on utilizing chatbots to improve ordering efficiency and provide education on sustainability. Green and Beans recommend using chatbots to provide environmentally friendly menu recommendations and support waste reduction, while Warung 1000 Kebun has developed a chatbot to provide education on waste reduction. Overall, chatbots in all restaurants play an important role in promoting environmental awareness and operational efficiency through approaches that are relevant to the needs of each restaurant.

Table 4. Interview Results

ASPECTS	KEY POINTS
Implementation of Zero-Waste Gastronomy	
Motivation for Adopting Zero Waste	Reducing environmental impact, promoting sustainability, minimizing food waste, educating employees and customers.
Initial Steps in Waste Reduction	Separating organic/non-organic materials, using materials that are typically discarded, composting, and recycling.
Ensuring Environmentally Friendly Materials	Local, seasonal, organic materials, collaboration with local farmers, avoiding plastic and hazardous chemicals.
Challenges and Solutions	Negative stigma toward "waste" materials, difficulty in obtaining affordable environmentally friendly materials, education and collaboration with suppliers.
The Role of Employees and Customers	Employees are involved in training, and customers are invited to participate through direct education and social media.
Technology and AI Chatbots	
Use of AI Chatbots	Potential to improve communication efficiency, recommend environmentally friendly menus, and reduce food waste.
Reducing Waste and Waste	Menu recommendations based on available ingredients and customer preferences.
Customer Education	Chatbots as a tool for educating customers about waste reduction and providing information on eco-friendly menus.
Customer Response	Positive response to technology that supports sustainability and choosing foods with low environmental impact.
Green Tourism	

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ASPECTS	KEY POINTS
Contribution to Green Tourism	Offering healthy and environmentally friendly food, local and organic ingredients, educating customers about sustainability.
Collaborating with Eco-Friendly Destinations	Several restaurants are open to forming partnerships with eco-friendly destinations in the future.
Tourist Interest in Eco-Friendly Cuisine	Growing, despite the stigma surrounding zero-waste menus, sustainability awareness among tourists is increasing.
Use of Local and Seasonal Ingredients	All restaurants use local and seasonal ingredients to support sustainability.
Tourist Education	Using social media, events, and direct communication to educate tourists about sustainability.
Closing (Future Expectations)	
Hopes for the Future of Culinary Arts	Hopes for sustainable culinary development, with more restaurants adopting zero waste principles and using local ingredients.
Future Challenges	Overcoming the stigma of zero waste ingredients, maintaining consistency in the implementation of sustainability, waste management, and operational costs.
Waste Reduction Measures	Improving waste management, introducing efficient ingredients, educating customers to participate in waste reduction.
The Role of Technology in Green Tourism	AI can help with operational efficiency, optimize raw materials, support customer education, and the green tourism sector.
Message for Other Food Businesses	Integrating sustainability into operations, collaboration, and innovation for environmentally friendly solutions.

Source: Data processed by researchers

Interviews with four restaurants revealed their strong commitment to sustainability and waste reduction through the implementation of Zero-Waste Gastronomy. These restaurants prioritize local, seasonal, and organic ingredients, and focus on educating employees and customers about waste management. They face challenges such as stigma against "waste" ingredients and the difficulty of obtaining environmentally friendly ingredients at affordable prices, but the solutions they have adopted include education and cooperation with suppliers. Technologies such as AI chatbots are expected to improve operational efficiency and educate customers about sustainability, although they have not yet been fully implemented. In addition, these restaurants also contribute to green tourism by promoting healthy and environmentally friendly food and using local ingredients. They hope that sustainable cuisine will continue to grow in Indonesia, despite challenges such as stigma and operational costs. Going forward, they will continue to focus on better waste management, more efficient use of materials, and utilizing technology to support sustainability and green tourism. This opinion is supported by Waheed, S., & Kumar (2024).

5. CONCLUSION

This study concludes that the application of AI chatbots in culinary ecotourism based on zero-waste gastronomy has significant potential in supporting green tourism sustainability. Although this technology has not been fully implemented by the restaurants studied, all four restaurants show great potential in reducing food waste through sustainable menu recommendations, order optimization, and education about sustainability. The implementation of zero-waste gastronomy principles in restaurants such as Para Sehat, Sugu Resto, Green and Beans, and Warung 1000 Kebun has shown an increase in tourist awareness

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of sustainability and the importance of choosing environmentally friendly foods. Education is carried out through various channels, including social media, direct communication, and workshops.

Despite the negative stigma surrounding "waste" food ingredients, educational efforts by restaurants have successfully raised tourist awareness of the positive impact of choosing foods that support sustainability. Technology, such as AI chatbots, is seen as an effective tool for improving food waste management and raising tourist awareness about sustainability. In the future, this technology is expected to help restaurants manage waste more efficiently and provide more in-depth education about environmentally friendly food consumption.

These restaurants further demonstrate their commitment to green tourism by using local, seasonal, and organic ingredients, as well as continuing to educate employees and customers about the importance of better waste management. Despite challenges such as stigma against "waste" ingredients and high operating costs, restaurants remain optimistic about the development of sustainable cuisine in Indonesia. They hope that in the future, more restaurants will adopt zero-waste principles and collaborate in creating environmentally friendly solutions that can support sustainability and green tourism more broadly.

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