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ORIGINAL

Enriching the tourist experience at the Santuario de las Lajas through image recognition using WhatsApp

Enriquecimiento de la experiencia turística en el Santuario de las Lajas mediante reconocimiento de imágenes por medio de WhatsApp

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ABSTRACT

The main objective of this research is to enrich the visitor experience at the Santuario de las Lajas through an interactive virtual assistant. With the adoption of advanced technologies in the tourism sector, such as the IoT, Big Data and mobile applications, there is an opportunity to address the lack of detailed information about the sanctuary and its cultural heritage. The scarcity of information points and tour guides affects visitors' understanding of the sanctuary's architecture and artistic representations, hindering their access to knowledge about this iconic place. In response to this need, an assistant was developed that, through WhatsApp and image recognition capabilities, allows visitors to obtain contextualised and accurate information about points of interest by sending photographs. To create the assistant, historical and cultural information about the sanctuary was collected and analysed through bibliographic sources, site visits and interviews with experts. The assistant was then implemented using artificial intelligence techniques to ensure appropriate responses to the context of each query. Once development was complete, a comprehensive evaluation was carried out to verify the effectiveness of the system in interpreting images and the accuracy of the information provided. The project not only contributes to the cultural understanding of the sanctuary, but also exemplifies the use of innovative technologies in the conservation and dissemination of cultural heritage, thus promoting a model of innovation applicable to other tourist destinations of cultural relevance.

Keywords: Tourism enrichment; Artificial vision; Chatbot; Cultural heritage; Artificial intelligence.

RESUMEN

Esta investigación tiene como objetivo principal enriquecer la experiencia de los visitantes en el Santuario de las Lajas mediante un asistente virtual interactivo. A raíz de la adopción de tecnologías avanzadas en el ámbito turístico, como el IoT, Big Data y las aplicaciones móviles, surge la oportunidad de abordar la falta de información detallada sobre el santuario y su herencia cultural. La escasez de puntos informativos y guías turísticos afecta la comprensión de su arquitectura y sus representaciones artísticas, obstaculizando a los visitantes en su acceso al conocimiento emblemático de este lugar. En respuesta a esta necesidad, se desarrolló un asistente que, a través de WhatsApp y capacidades de reconocimiento de imágenes, permite a los visitantes obtener información contextualizada y precisa sobre los puntos de interés mediante el envío de fotografías. Para la creación del asistente, se recopiló y analizó información histórica y cultural del santuario mediante fuentes bibliográficas, visitas al lugar y entrevistas a expertos. Posteriormente, se implementó el asistente con técnicas de inteligencia artificial para asegurar respuestas adecuadas al contexto de cada consulta. Una vez completado el desarrollo, se realizó una evaluación exhaustiva para verificar la efectividad del sistema en la interpretación de imágenes y la precisión de la información ofrecida. El proyecto no solo

contribuye a la comprensión cultural del santuario, sino que también ejemplifica el uso de tecnologías innovadoras en la conservación y difusión del patrimonio cultural, promoviendo así un modelo de innovación aplicable a otros destinos turísticos de relevancia cultural.

Palabras clave: Enriquecimiento Turístico; Visión Artificial; Chat-Bot, Patrimonio Cultural; Inteligencia Artificial.

INTRODUCTION

Currently, advances in technologies such as IoT, Big Data, Blockchain, and Mobile, among others,[1,2,3] when applied in tourism environments, have transformed the industry, significantly enhancing the visitor experience.[2,4,5,6] In this context, the focus of the present research is on the Sanctuary of Las Lajas, a place of profound historical and cultural relevance, recognized as an architectural jewel of Colombia.[3,7,8,9] Its importance transcends national borders, capturing international attention and attracting a multitude of tourists eager to explore its rich heritage.[10,11,12]

Considering the above, a lack of detailed and contextual information for visitors to Las Lajas Sanctuary has been identified, which affects tourists' understanding of the historical and cultural richness of this place. The scarcity of historical information points and tourist guides makes it difficult for visitors to gain knowledge about aspects ranging from architecture to artistic representations. As a result, tourists encounter obstacles in accessing this emblematic knowledge effectively.[13,14,15,16,17]

Faced with the need to overcome information limitations at the Sanctuary of Las Lajas, an initiative to implement a virtual assistant with image recognition capabilities on the popular instant messaging platform WhatsApp was developed. The application of this solution provides precise and detailed answers about the points of interest identified in the sanctuary. In this way, it is expected to establish an authentic connection between visitors and the valuable cultural heritage that characterizes this place.[18,19,20,21,22,23]

Detailed information about the Sanctuary of Las Lajas, including artistic manifestations, was also collected. This process was carried out through a rigorous review of bibliographic materials, site visits, and interviews with expert historians of the Sanctuary of Las Lajas.[24,25,26,27,28] Subsequently, we proceeded with the development of the virtual assistant, focusing on its ability to recognize images through WhatsApp to provide accurate and contextually relevant answers. Finally, a thorough evaluation was conducted to ensure the effectiveness and accuracy of the virtual assistant in interpreting images and delivering appropriate responses.[29,30,31,32,33,34]

The ongoing research aimed to enhance the tourist experience at the Sanctuary of Las Lajas by implementing new technologies, pushing the boundaries of tourism through innovation in artificial intelligence, and utilizing WhatsApp as a platform for this purpose. This approach aimed to enhance the tourist experience in the realm of cultural heritage. In addition to benefiting the Sanctuary of Las Lajas, the project promotes innovation and the implementation of technologies in cultural heritage.[35,36,37,38]

This document includes all the essential information for the development of this project, including the research problem, objectives, theoretical framework, methodology, research results, analysis of results, conclusions, and recommendations. Adequately structuring the project to meet the proposed goals.

Formulation of the problem

How to address the lack of tourist information on the cultural heritage of the Sanctuary of Las Lajas, focusing on the richness of artistic and cultural manifestations?

General Objective

To enrich the tourist experience in the Santuario de las Lajas by implementing a virtual assistant with image recognition through WhatsApp, fostering an authentic connection between visitors and the valuable heritage of the place.

METHOD

Paradigm

In the context of this project focused on the Sanctuary of Las Lajas, the positivist paradigm is implemented, which seeks the good development of the proposed objectives and inquires into the best possible solution for a large amount of information or data. Thus, it focuses on collecting empirical data. Its main aim is to evaluate the effect of the virtual assistant on enriching the tourist experience and enhancing the understanding of cultural heritage. Likewise, to establish causal relationships between variables, allowing for the identification of patterns that guide the interaction between users and the implemented technology. This provides a solid methodological framework to accurately and reliably measure the impact of the virtual assistant, given that

the positivist paradigm is characterized by the high interest in the verification of knowledge, as well as the establishment of a set of predictable hypotheses that are later tested,[39] thus contributing to the optimization of the interaction between humans and technology in the context of the Sanctuary of Las Lajas.

Approach

The project is framed within a quantitative approach to address the information gap experienced by visitors to the Sanctuary of Las Lajas. Thus, opting for an applied quantitative research approach to integrate artificial intelligence techniques for image recognition. The applied methodology combines a quantitative approach to evaluate the quality of image recognition accuracy. Since this quantitative approach is both analytical and empirical, it aims to answer questions based on a study sample.[40] Therefore, using this approach was indispensable to provide visitors with detailed and enriching information about the cultural heritage of the Santuario de las Lajas.

Method

To bring an exemplary methodology to development, this thesis project is characterized by a rigorous scientific method. An iterative development process of the virtual assistant with image recognition on the WhatsApp messaging platform was carried out. This process included various procedures involved in the scientific method,[41] such as the observation of the current situation in the sanctuary of Las Lajas, which allows for data collection, as well as evaluating the effectiveness and current satisfaction of visitors, so that a hypothesis could be generated according to the reaction of what the virtual assistant could cause when it is implemented in the sanctuary. With this, we aimed to assess the impact of the virtual assistant on enriching the tourist experience at the Las Lajas Sanctuary. In this way, the application of this detailed scientific approach guaranteed not only the effectiveness and precision of the virtual assistant but also the excellence and satisfaction of the tourist experience at the Sanctuary of Las Lajas, thus providing substantial enrichment to visitors.

Type of research

The research is classified as experimental research.[42] Controlled interaction tests were conducted with the virtual assistant to evaluate its performance and user experience. This experimental approach enables the assessment of effectiveness, thereby contributing to the validity and reliability of the results obtained.

Research design

The project is focused on developing a Virtual Assistant via WhatsApp for image recognition in the Sanctuary of Las Lajas. A pre-experimental approach was employed to conduct a single measurement following implementation. This allowed us to evaluate the impact of the interaction between visitors and the virtual assistant, thus providing valuable information about the initial user experience. Although this design is initial, future research could benefit from more detailed approaches to provide a comprehensive evaluation of virtual assistant performance. The research design can be expressed as follows: experimental research development:

- G1: Group 1.
- G2: Group 2.
- O: Tests.
- X: Experimental Treatment. G1 è O1 è - è O2.
- G2 è O1 è X è O2.

In the experimental research, there were two groups: the control group and the experimental group. First, before implementing the experimental evaluation, an O1 test was administered to both groups to assess the level of knowledge of the groups regarding the Sanctuary of Las Lajas, ensuring that both groups had a similar understanding. Secondly, the control group began their touristic tour through the Sanctuary of Las Lajas normally, without the intervention of the virtual assistant, and at the end, they were asked to complete the O2 test. To continue, the virtual assistant was introduced in the experimental group, and they began their tour of the Santuario de las Lajas. At the end, they filled out test O2. Once the tests with the control and experimental groups were completed, the results were analyzed. This involved comparing the results of the experimental group, obtained in the O2 test, with those of the control group, also obtained in the same O2 test. In this way, the results obtained in the comparisons allowed verifying the difference or impact that the virtual assistant had in the Santuario de las Lajas.

Population

The target population of this project comprises visitors to the Santuario de las Lajas, encompassing any person who accesses the WhatsApp messaging platform and uses it to interact with the virtual assistant that was developed.

Sample

The sample was selected non-probabilistically, as the decision to participate in the project depends entirely on the visitors. Likewise, the number of visitors found on the day of the chatbot test led to the selection of visitors randomly, who agreed to participate in the study. The specific sample size was determined based on practical factors and the available resources for conducting the tests and interviews. The effectiveness of the December and January periods is highlighted, given that during these months thousands of people visit the Santuario de las Lajas daily,[43] however, due to the existing crowds at this time, it was considered to take the sample in September, given that in this month the Quincentenary Festival is celebrated. For the people of Nariño, the pilgrimage to this sanctuary during the patron saint's festivities is sacred.[44] This allowed the collection of significant data on the interaction between users and the virtual assistant in this context.

Data collection techniques

Documentary review and archival research provided context. The first phase consisted of face-to-face surveys, which allowed for direct contact with visitors. Semi-structured interviews with local experts provided historical and cultural perspectives. Similarly, these strategies, when integrated with authenticity and multiculturalism, provided a solid foundation for understanding the development of the Sanctuary of Las Lajas and the implementation of the virtual assistant.

Validity of the collection techniques

The chosen techniques are based on the synergy between cultural heritage and technology. Face-to-face surveys[45] as a means of observation, visitors' reactions. Semi-structured interviews[46] with local experts and tradition followers enhance the historical and spiritual atmosphere of the sanctuary. Analysis of historical documents[47] adds depth to the context. This combination of approaches, based on cultural respect and authenticity, promises a deep and authentic understanding. Likewise, consultation with experts such as consultant Jorge Albeiro Rivera R. and research professors Marleny Mayani López B et al.[47] adds depth to the context. Luis Arnoby Escobar H., ongoing research and feedback from local communities ensure accuracy and relevance, thus strengthening research at Las Lajas Sanctuary.

Reliability of collection techniques

Reliability depends on precautions and procedures. Face-to-face surveys, as a well-documented avenue of observation, provide accurate information on tourism interactions. A semi-structured interview guided by specific questions provides detailed and uniform information. Cross-checking historical documents and local statistics adds credibility. Transparent methods and consistent results ensure reliability. In addition, the ongoing involvement of local communities in the process that validates cultural encounters enhances the integrity and reliability of the methods used in the Las Lajas Sanctuary study for implementing the virtual assistant via WhatsApp.

Data collection instruments

Cameras capture detailed images, a technique that is part of the information-gathering process, which is observation. Recording equipment records local stories and interviews. Semi-structured surveys before and after the project, the before survey can be found in Annex 1, and the after survey can be found in Annex 2. These tools, supported by technology and adapted to the local communities, were essential for the complete and accurate documentation and analysis of the heritage of Las Lajas Sanctuary.

RESULTS

This chapter details the development and results of the virtual assistant implemented at the Las Lajas Sanctuary. The project involved several stages, starting with the collection and analysis of historical and cultural data from the sanctuary, which served as the basis for developing an artificial intelligence model using agile techniques and advanced image processing methods. Likewise, a chatbot based on the BuilderBot framework was designed to interact with users through WhatsApp, allowing visitors to access personalized information about architectural and historical aspects of the site. In addition, an experimental evaluation was carried out to measure the effectiveness of the assistant in improving the experience and knowledge of visitors, the results of which evidence a positive impact on the understanding of the cultural heritage of the Sanctuary of Las Lajas.

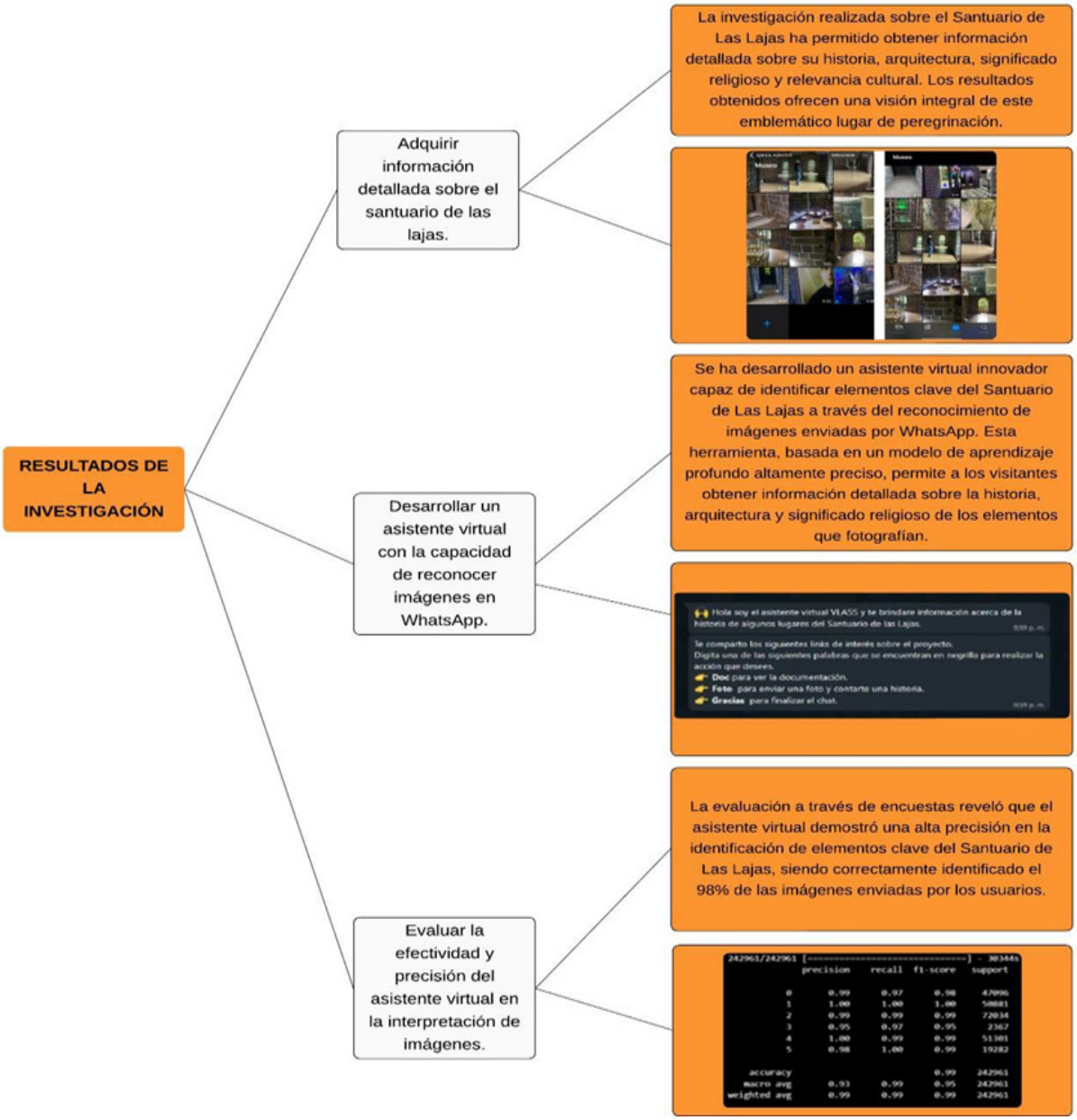

Figure 1. Summary of results

Acquire detailed information about the Las Lajas Sanctuary.

Historical and Cultural Documentation of the Las Lajas Sanctuary

The objective of acquiring detailed information about the Las Lajas Sanctuary, including its historical and cultural elements, was achieved through an integrated approach that included bibliographic research, visits to the Sanctuary, and interviews with cultural heritage experts. The activities undertaken to achieve this objective are outlined below.

Visits to the Las Lajas Sanctuary

Visits to the Sanctuary were essential to obtain visual and experiential information about the historical and cultural elements of the site. A specific trip to the Sanctuary was made in the afternoon, arriving at approximately 6:00 pm. The primary purpose of this visit was to capture high-quality (4K) videos of the most representative areas previously identified with the project advisor, specialist Jorge Alveiro Rivera Rosero.

During the visit, videos of the following most representative places of Las Lajas Sanctuary were collected:

- Gratitude plaques.
- Angels.
- Outside areas of the church.
- Interior regions of the church.
- The electrical plant.
- The museum.

These videos were captured in two phases: one at night, taking advantage of the light exposure to highlight nocturnal details, and another in the morning of the following day to capture the same areas under different lighting conditions. This strategy enabled the acquisition of a comprehensive and contrasting view of the Sanctuary's visual elements. In total, 166 high-quality (4K) videos were collected, which were essential for developing a training dataset for the project's artificial intelligence model.

Expert Interviews

During the night visit, an opportunity arose to conduct a spontaneous interview with Camilo Andrés Varona Guerrero, a departmental documenter in oral tradition and graphic designer, as well as a contemporary master artisan at CESMAG University. Camilo Varona was telling stories to a group of visitors, and his knowledge of the Sanctuary's cultural heritage proved to be an invaluable resource. Contact with Camilo Varona enabled us to obtain stories about the Las Lajas Sanctuary that were crucial in complementing the bibliographic research and guiding the selection of the most relevant stories for the project.

Interviews were also conducted with other local people the following day, who provided detailed information about the Sanctuary's history, thereby enriching our knowledge of its cultural and historical aspects. These interviews contributed significantly to identifying key narratives that could be explored in greater depth.

Bibliographic research

With the guidance obtained from the interviews and visits, an exhaustive review of bibliographic sources was conducted to delve deeper into the history of the Santuario de las Lajas. This review encompassed books, academic articles, and historical records that detailed the Sanctuary's most significant events, as well as its cultural and religious development.

The bibliographic analysis enabled us to establish a solid foundation for selecting the stories to be used in the project. Through this research, six main stories were identified, each linked to a representative class of the Sanctuary's most emblematic places. These historical and cultural stories formed the narrative component of the virtual assistant.

Information Processing and Organization

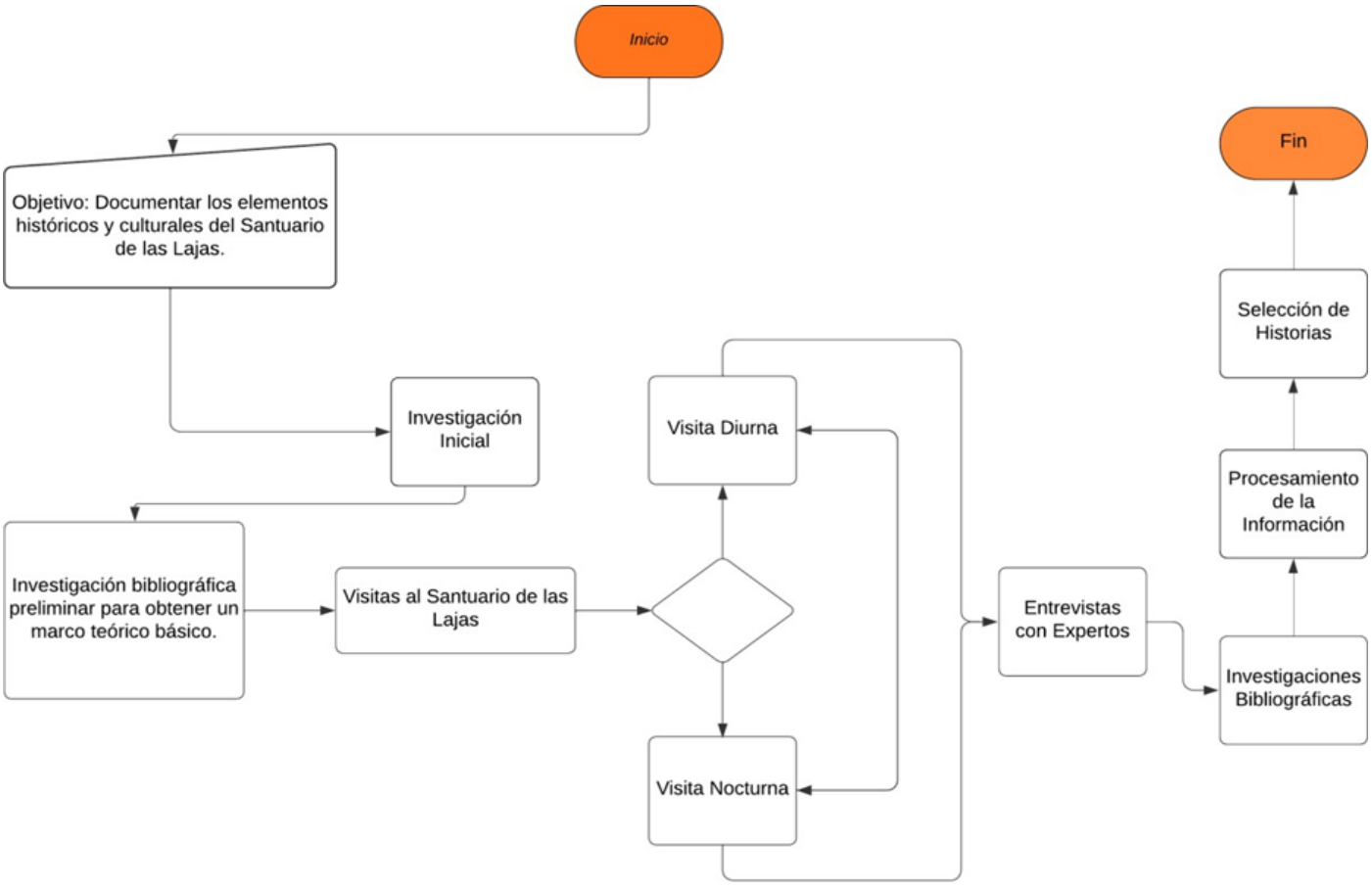

Figure 2. Flowchart of development of the specific objective

The collection of videos was not only used for visual research purposes, but also for creating an extensive dataset. Using Python, the videos were decomposed into frames, resulting in a total of 242 961 images distributed in six folders, each corresponding to a representative class of the Sanctuary. This dataset was used to train the artificial intelligence model responsible for recognizing the locations within the shrine and associating a specific story with each one.

The process of organizing and selecting the information also included identifying the best stories for each representative class. The review of the interviews, combined with the information gathered from the bibliographic research, enabled the construction of a corpus of stories that was well-founded and coherent with the Sanctuary's cultural and historical elements.

Develop a virtual assistant with the ability to recognize images in WhatsApp

The virtual assistant for the Las Lajas Sanctuary is an innovative digital tool that, through the WhatsApp messaging application, allows visitors to obtain detailed information about the site's cultural heritage. Using an artificial intelligence model trained with an extensive dataset of images, the assistant can identify architectural elements, works of art, and religious objects within the sanctuary. By sending a photo via WhatsApp, users receive relevant historical, artistic, and spiritual information about the identified element.

Start of development

In the initial phase of the project, the fundamental requirements for the model supporting the virtual assistant were determined. After an exhaustive analysis, it was decided to use existing training techniques to perform transfer learning and to analyze techniques that would allow extending the prediction percentage of the model, subsequently, it was identified how to create how the model would be connected to WhatsApp, opting for BuilderBot,[48] which is a free and open source framework with an intuitive and extensible way to create chat-bots and intelligent apps that connect to different communication channels such as WhatsApp, Telegram and others, likewise the respective meeting was held to make the functional and non-functional requirements of both the AI model and the chat-bot to create the product backlog which will give us an order with which to begin the development of the project.

AI Model

The development of the image recognition model for the virtual assistant was carried out following the CRISP-DM (Cross-Industry Standard Process for Data Mining) methodology,[49] which structured the process in six key phases, from business understanding to model deployment. The implementation of each of these phases is described below.

Business Understanding

The first phase consisted of understanding the environment and points of interest of the Sanctuary of Las Lajas, as the virtual assistant, named VLASS, would be intended to provide answers based on images of this place. Through face-to-face questions to visitors and experts, six key areas in the sanctuary were identified that represent the most striking and representative elements:

- Angels.
- Interior of the church.
- Exterior of the church.
- Museum.
- Thank you plaques.
- Power plant.

These six locations formed the classes that the model should be able to recognize, which allowed the focus and data needed for training to be clearly defined.

Understanding the Data

The next phase focused on collecting visual data to train the model. A total of 166 videos were recorded in 4K resolution at the six representative sanctuary locations. The videos were captured both during the day and at night to ensure that the model could recognize images in different lighting conditions. These videos would form the dataset needed for training the artificial intelligence model.

Data Preparation

With the collected videos, we proceeded to decompose each one into individual frames using the OpenCV library in Python. This process lasted approximately one week, resulting in a total of 242 961 images, distributed across six classes, each corresponding to a selected location within the sanctuary. This collection of images constituted the final dataset used to train the image recognition model.

Modeling

With the dataset prepared, the convolutional neural network (CNN) model was developed using Google Colab as the programming environment. The dataset was divided into two parts:

Eighty percent of the images (194 371) were intended for model training, and the remaining 20 % (48 590) were for validation.

To improve the model's accuracy, techniques such as data augmentation and transfer learning were applied, utilizing pre-trained models including MobileNetV3, VGG16, and InceptionV3. After several tests, it was decided to continue with the InceptionV3 model, as it provided the best results in terms of image classification accuracy.

The model was trained for 100 epochs, enabling the convolutional networks to identify the six classes defined in the previous phases accurately. Thanks to adjustments and optimizations, the model achieved a high level of accuracy in its predictions.

Evaluation

To evaluate the model's performance, the 48 590 images reserved for validation were used, representing 20 % of the total dataset. During this phase, a classification report was generated, showing positive results with high accuracy in class prediction, as evidenced in figure 3 (Classification report). The effectiveness of the model was proven, allowing for advancement to the final deployment phase.

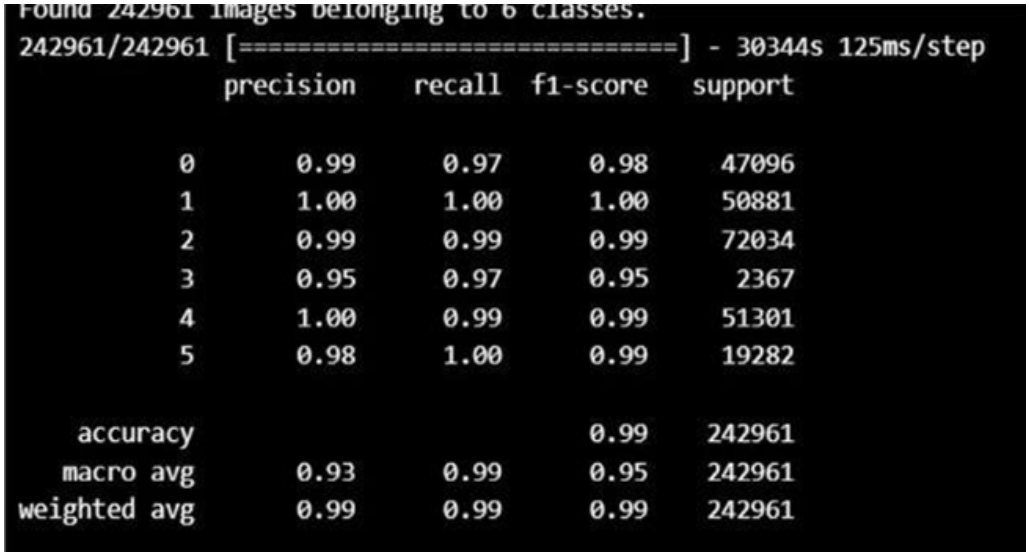

Figure 3. Classification report

Deployment

The trained model was exported in .h5 format, which facilitated its integration with the virtual assistant. To connect the model with the chatbot, the Flask service was used, which allows handling image requests sent by users through WhatsApp. The chatbot, upon receiving an image, consults the displayed model and obtains the prediction of the corresponding class, thus providing a detailed and contextualized response about the place recognized in the image.

In this way, the development of the image recognition model was completed, fulfilling the requirements for effective use in the project's virtual assistant. The model is capable of correctly identifying the six most representative points of interest of the Sanctuary of Las Lajas, providing a solid basis for the operation of the chatbot.

BuilderBot

It was decided to use BuilderBot as it is a flexible and scalable framework designed to simplify the creation of chatbots that integrate with platforms such as WhatsApp and Telegram. Its modular architecture, based on conversation flows, interchangeable connectors, and an adaptive data persistence layer, allows developers to build custom and robust chatbots quickly by separating the different responsibilities of the chatbot.

For the creation of the chatbot it was necessary to focus on three key components for its proper functioning: the Flow, in charge of building the conversation context and providing a developer-friendly interface; the Provider, which acts as a connector allowing to easily switch between WhatsApp providers without the risk of affecting other parts of the chatbot; and the Database, which, in line with this connector philosophy, facilitates the change of the data persistence layer without the need to rewrite the workflow.

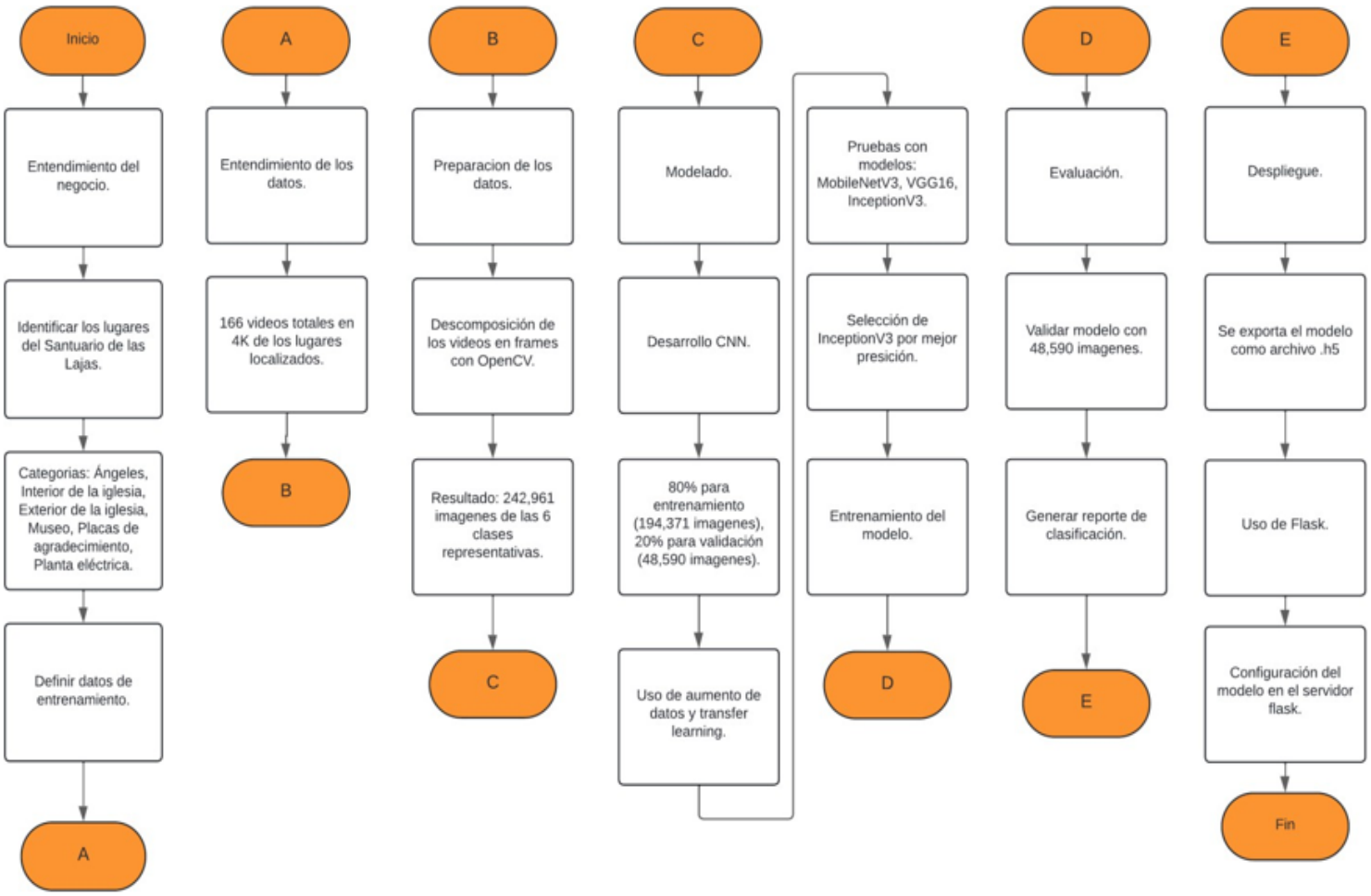

Figure 4. Flowchart of development of specific objective 2 - Model

Programming language

For the chatbot language, after a problem was encountered in receiving images with JavaScript, TypeScript was used because its static typing system enabled early error detection, improved code readability, and facilitated collaboration among developers. Additionally, its object-oriented nature facilitated the organization of the code into well-defined modules and the creation of reusable components. When working with a project of this nature, where accuracy and reliability of information are paramount, TypeScript provided a solid foundation for building a virtual assistant capable of responding to user queries accurately and efficiently.

Provider

We then moved on to investigate different providers responsible for establishing the communication bridge between the bot and messaging platforms, such as WhatsApp, Telegram, or any other messaging platform. These providers enable the bot to interact efficiently with various messaging services, facilitating seamless integration and message delivery across multiple communication channels. After extensive research, Bailey's was chosen.

Baileys

Which, being an open source project that allows sending messages, receiving messages, and dozens of other functionalities by implementing WebSocket in a version of WhatsApp, facilitated in a more efficient way the customization and control over the interactions performed by the bot.

```
import { createBot, createProvider, createFlow, addKeyword } from '@builderbot/bot'
import { BaileysProvider as Provider } from '@builderbot/provider-baileys'
```

Source: https://www.builderbot.app/en/providers/baileys
Figure 5. Baileys implementation

Database

Similarly, it was established that the main objective of the database within the bot is to provide a record of the different events that have occurred between different conversations as well as to house the stories cataloged between 0 and 5 representing each representative class of the slab sanctuary, so PostgreSQL was chosen.

PostgreSQL

The PostgreSQL database was used, as it is renowned for its reliability and state-of-the-art features, as well as having formidable data warehousing solutions for bot-generated responses. Seamless integration with PostgreSQL involves specifying vital parameters such as host, user, password, database, name and port. This database variant ensures data integrity and scalability, making it optimal for applications that require world-class data storage and retrieval performance.

```
import { PostgreSQLDB } from '@builderbot/database-postgres'

export type IDatabase = typeof PostgreSQLDB
export const adapterDB = new PostgreSQLDB({
    host: POSTGRES_DB_HOST,
    user: POSTGRES_DB_USER,
    database: POSTGRES_DB_NAME,
    password: POSTGRES_DB_PASSWORD,
    port: +POSTGRES_DB_PORT,
})
```

Sources: https://www.builderbot.app/en/databases#postgres

Figure 6. PostgreSQL implementation

The Flow

Finally, it was necessary to implement structured sequences of interactions, which are similar to the creation of conversation flows. Among the key methods identified are addKeyword and addAnswer, which allow keywords to be associated with specific responses. This functionality provides the ability to customize the interaction flow, adjusting responses based on the keywords set, which optimizes the experience and accuracy in automated communication.

```
// Example with single keyword
addKeyword('hello').addAnswer('Ey! welcome')


// Example with multi keywords
addKeyword(['hello','hi']).addAnswer('Ey! welcome')
```

Source: https://www.builderbot.app/en/concepts

Figure 7. Example of conversation flow

Union and client-server Api

Once having developed both the model and bot, we proceeded to perform the union of the same, this was carried out by running the command (Python -m venv flask) to create the flask folder, which is a web server that allows us to be the medium for communication between model and chat-bot, we also continue installing the necessary dependencies for the proper functioning of the same, such as:

- Flask: a microframework for web applications in Python.
- Flask-CORS: this package allows the handling of Cross-Origin Resource Sharing (CORS) in Flask applications. CORS allows a web application to make requests to a different domain than the one that served it.
- OpenCV (cv2): library for image manipulation and computer vision.
- NumPy: library for matrix manipulation and mathematical operations.

- BytesIO (from io): provides an in-memory input/output stream, which allows image data to be handled as if they were files without writing them to disk.
- Tensor Flow and Keras: libraries for the development and execution of deep learning models.

Software architecture

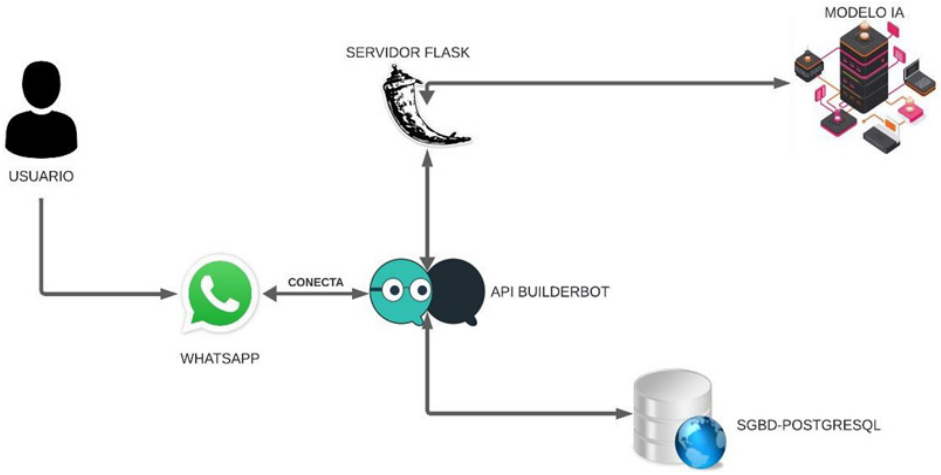

Figure 8. Software architecture

Similarly, a .py file was created which houses the code to interact both model and bot, in which first the model is loaded already made, then receives the image through flask that is connected to the bot code and converts it to an array, once it is as array the process is performed to predict the image which yields an answer that can be between 0 and 5, this numerical value represents each of the classes among which the images of the sanctuary of the flagstones were cataloged being specifically:

- Angels.
- Interior of the church.
- Exterior of the church.
- Museum.
- Plaques of gratitude.
- Electric plant.

This response is hosted on the flask server, so that the bot, upon receiving it, searches the database for a story that matches the representative class that indicates the response predicted by the model.

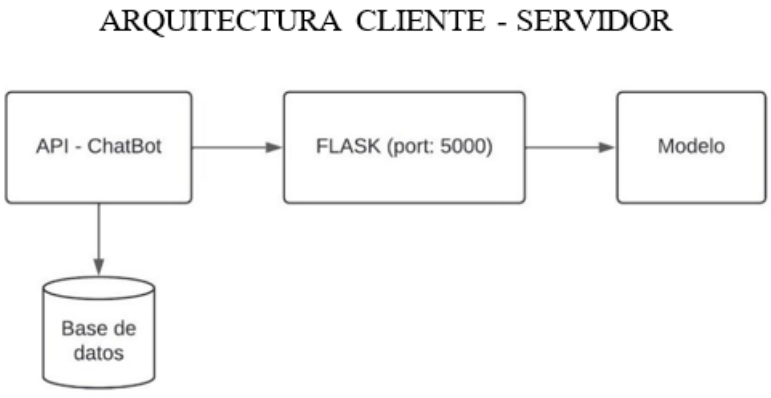

Figure 9. Client-server architecture

End of development

Once the development phase of the virtual assistant was completed, a rigorous testing and adjustment process was carried out. Thanks to the feedback obtained, improvement opportunities were identified and implemented in an agile manner, thus guaranteeing a final product that meets the expectations and needs of the users.

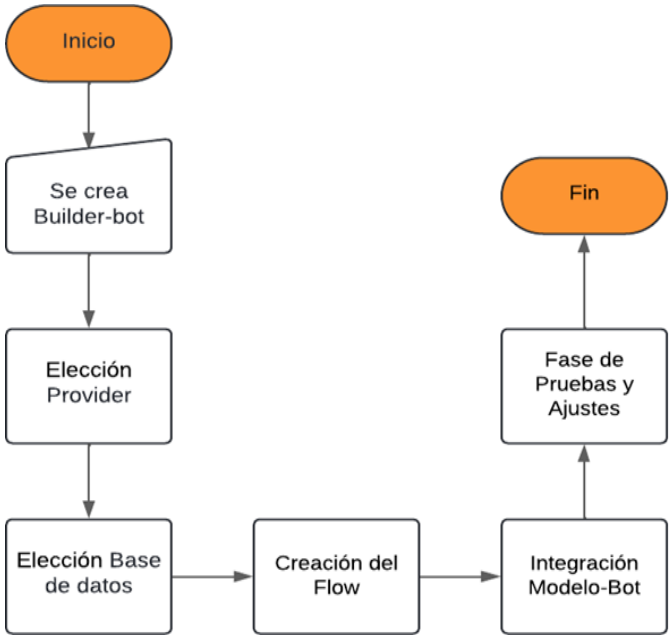

Figure 10. Flowchart of development of specific objective 2 - ChatBot

Evaluate the effectiveness and accuracy of the virtual assistant

For this objective we sought to evaluate the impact of the virtual assistant on the knowledge and experience of visitors to the Sanctuary of Las Lajas. The results obtained show conclusively that the implementation of this technological tool has generated a significant increase in the level of knowledge and understanding of visitors regarding the religious, historical and architectural heritage of the place.

METHOD

A two-group experimental design was used for the evaluation:

- Control group (G1): the visit was carried out in the traditional way, without the assistance of the chat-bot.
- Experimental group (G2): Interacted with the virtual assistant during their visit to the sanctuary.

Measuring instruments

Two tests O1 and O2 were used to evaluate the visitors' level of knowledge before and after the visit:

- O1: survey before the chat-bot: applied to both groups before the visit, with the objective of analyzing that the groups had a similar initial level of knowledge.
- O2: survey after the chat-bot: applied to both groups at the end of the visit, to evaluate the increase in knowledge acquired.

Procedure

Application of test O1: both groups responded to test O1 to assess their initial knowledge about the Las Lajas Sanctuary.

Control group (G1): participants conducted the visit in the traditional way, without access to the virtual assistant.

Experimental group (G2): participants used the virtual assistant during their tour, resolving doubts and obtaining additional information.

Application of the O2 test: both groups answered the O2 test again to evaluate the knowledge acquired after the visit.

RESULTS

Test 01

When applying test O1, the results obtained, reflected in (figure 11 result question 1, survey 1), indicate that most of the respondents have visited the Las Lajas Sanctuary. This suggests that, in general, visitors should be familiar with the basic information about the site. However, analyzing the responses to the next question (figure 12 result question 2, survey 1) reveals what their experience was like without the interaction of a virtual assistant. According to the data, 76,9 % of the respondents rated their visit as "fair", i.e., an average experience. Some 15,4 % felt that their visit was excellent and met their expectations, while the rest rated their experience as good or were unsure of their rating. These results show that, although most visitors

had already been to the Sanctuary, their visits were generally ordinary, with few people delving into the rich cultural and historical heritage of the site, resulting in a truly excellent experience for a small group.

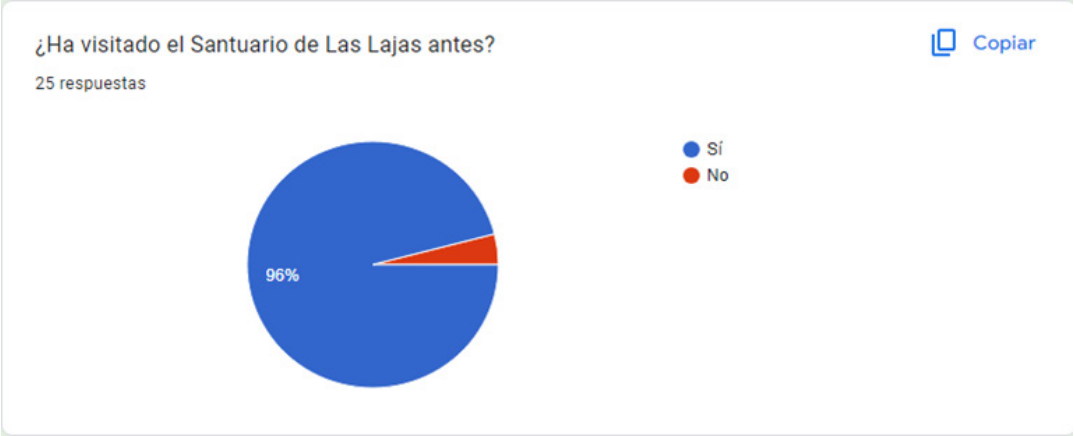

Figure 11. Results of question 1, survey 1

Figure 12. Results of question 2, survey 1

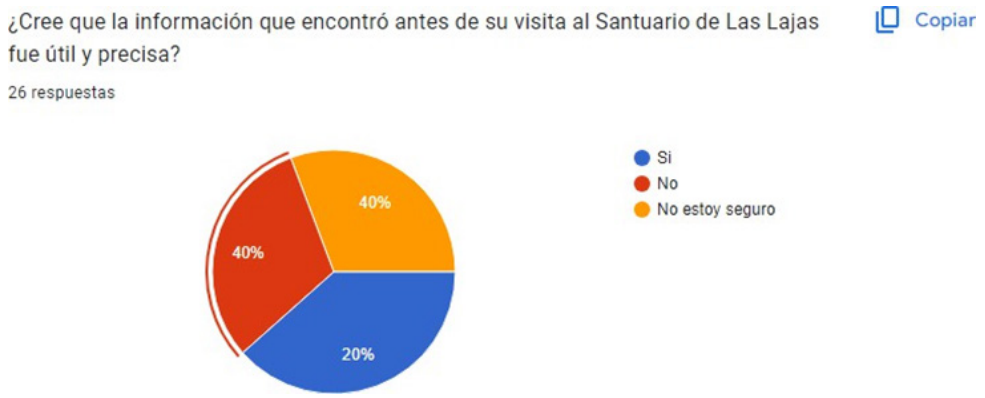

Figure 13. Results of question 3, survey 1

Once the previous results have been identified, it is also feasible to analyze the information that people can obtain before they visit the Sanctuary of Las Lajas (figure 13 result of question 3, survey 1) to analyze if people can obtain information about the places of the Sanctuary of Las Lajas and this allows them to have an enriching experience, however, the results obtained allow analyzing that only 20 % of the visitors found information that is useful for their visit to the Sanctuary, while, 40 % did not obtain helpful and precise information, which allows identifying that visitors do not search for information or do not find information available at the Sanctuary, in the same way, 40 % are not sure of the information obtained, which allows concluding that the information that these visitors could obtain could not be reliable or helpful to improve their experience. These findings enable the identification of whether the information provided by the virtual assistant will help enrich their tourist experience at the Sanctuary of Las Lajas.

Test o2

Figure 14. Results of survey 2

After analyzing the results of the surveys conducted in Test 1 and the data presented in figure 14 (survey result 2), it is concluded that, before the implementation of the virtual assistant, most visitors lacked sufficient information, which made their experience at the Sanctuary routine. However, with the incorporation of the virtual assistant, 95 % of the respondents stated that their expertise improved significantly after interacting with the tool during their tour of the Sanctuary of Las Lajas. These results demonstrate that the virtual assistant provides tourists with valuable information, enhancing their visit and making it a more enriching and satisfying experience, which contributes to a substantial improvement in the overall tourist experience at the Sanctuary of Las Lajas.

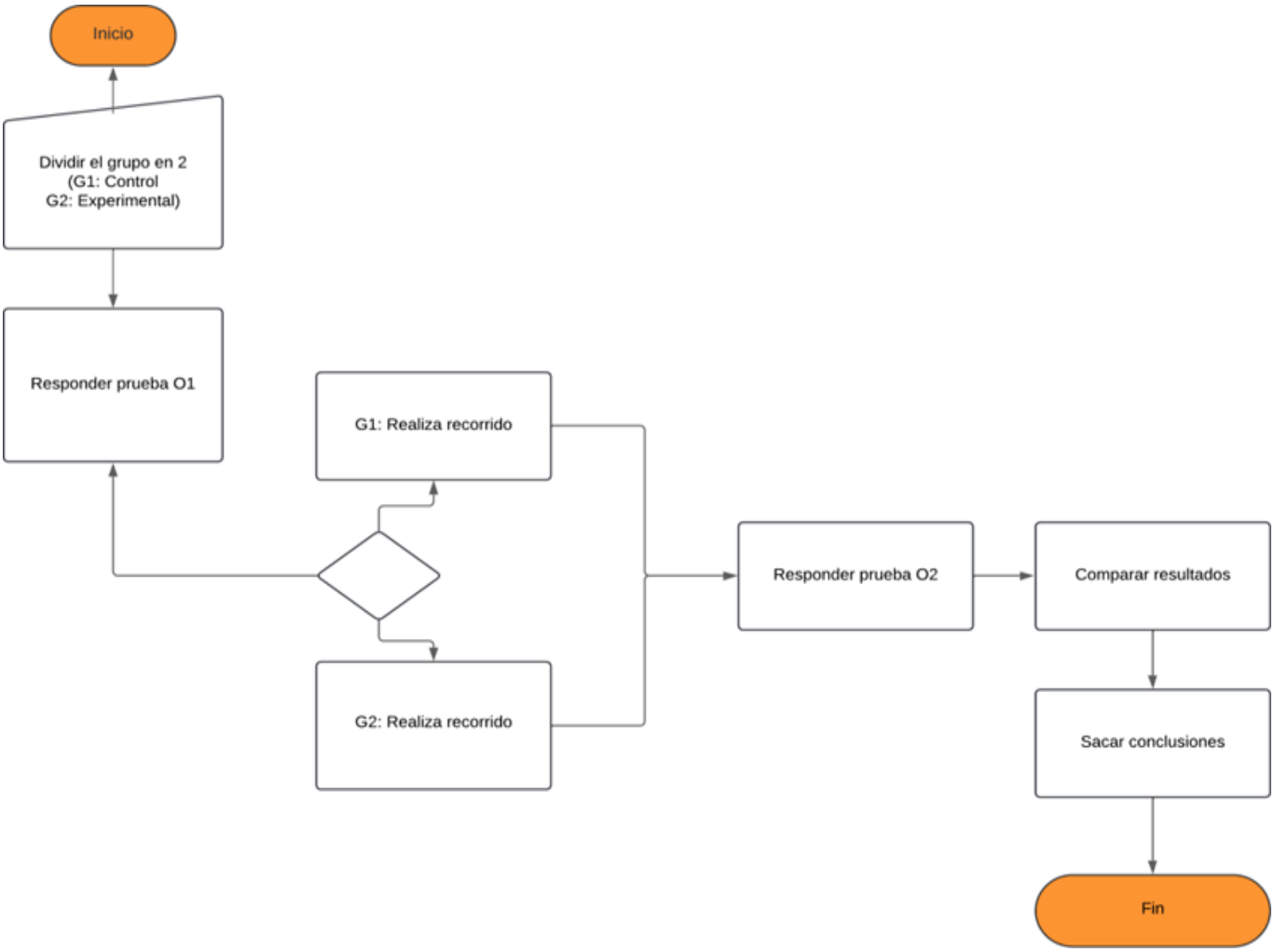

Figure 15. Flowchart of development of specific objective 3

Analysis of results

An analysis is conducted of the results achieved through the evaluations of the virtual assistant implemented at the Sanctuary of Las Lajas. These findings will be compared with theories and research involving the use of technologies and virtual assistants to optimize the user's experience, while also promoting patrimonial and cultural knowledge.

Impact of the virtual assistant on the tourist experience

The research conducted revealed that the application of the virtual assistant enabled tourists to enjoy a more pleasant experience at the Sanctuary of Las Lajas. Before the implementation of this technology, 76,9 % of the survey participants classified their visit as "regular", indicating that their experience was daily and did not leave a lasting impression. However, after interacting with the virtual assistant, 95 % of the survey participants reported that their experience was significantly more enriching, indicating a clear positive impact.

Virtual assistants and the improvement of the user experience

Theories and research have demonstrated that virtual assistants, such as chatbots, are crucial tools for providing real-time access to relevant information about products and services offered by public and private entities. According to Makasi et al.[50], the development and implementation of these virtual assistants significantly enhance the interaction between users and services, generating more enriching and personalized experiences. This theory supports the results of the research conducted.

For the Sanctuary of Las Lajas, the virtual assistant functioned as a guide, offering detailed information about the architecture, history, and cultural elements of the site. This tool not only made it easier for users to increase their knowledge but also to retain it as a more enjoyable life experience. This beneficial effect on tourism is primarily the result of technological advances applied in key areas of the sector. As Carla Berrino[51] points out, technology has become a key element in cultural tourism, demonstrating how advanced technology has revolutionized the industry, especially in places where its influence is more pronounced. The virtual assistant presented for the Las Lajas Sanctuary, VLASS, is a clear example of how technological advances can culminate in a significantly enhanced tourism experience, aligning with significant developments in the sector.

The combination of this research reinforces the effectiveness of virtual assistants as tools to enrich the tourism experience, especially in cultural and historical environments such as the Sanctuary of Las Lajas.

Increase in heritage knowledge

Another significant finding was that visitors increased their understanding of the historical, cultural, and architectural legacy of the Sanctuary. In test O2, carried out after the interaction with the assistant, the visitors were found to have obtained extra data that they did not previously have. This demonstrates remarkable progress in interpreting the historical significance of the Sanctuary.

Role of technology in the dissemination of cultural heritage

Pablo Guijarro Marco[52] suggests that information technologies, such as chatbots and virtual assistants, are practical tools for disseminating information. These technologies enable the transmission of information in a manner that is both accessible and understandable to broad audiences. In the case of the Sanctuary of Las Lajas, the virtual assistant not only resolved visitors' doubts by providing a history of the site but also expanded their knowledge about historical aspects that would have otherwise gone unnoticed. As CORDIS | European Commission[53] points out, technology can play a fundamental role in the preservation and conservation of cultural heritage by making relevant information easily accessible and attractive to visitors.

Effectiveness of the information provided.

Before the introduction of the virtual assistant, the information situation for visitors was deficient. Only 20 % were able to access valuable data before their visit. On the other hand, 40 % of visitors encountered obstacles when searching for accurate information, and the remaining 40 % were suspicious of the reliability of the data they were able to collect. This picture contrasts markedly with the results obtained after the implementation of the chatbot, where the majority of respondents stated that the information provided by the virtual assistant was of great value and contributed significantly to improving their experience during the visit.

Quality of information in virtual assistants

It is worth noting that the information provided by the virtual assistant about the Sanctuary of Las Lajas enabled visitors to understand better and appreciate the cultural and architectural richness of the place. Likewise, the information provided by the VLASS virtual assistant aligns with the cultural heritage cycle described by Simon Thurley, who maintains that the first step in appreciating heritage is to understand it. Understanding not only generates greater appreciation but also fosters protection and enjoyment of heritage,

promoting a continuous cycle of learning and conservation that ultimately enhances the tourism experience and visitor satisfaction.[54,55]

Based on the above results, the research group determines that the formulated research hypothesis was achieved.

CONCLUSIONS

To develop a relevant and accurate virtual assistant, it was essential to conduct an exhaustive compilation of historical and cultural information. The research and interviews conducted enabled the discovery of the historical, cultural, and patrimonial richness represented by the Sanctuary of Las Lajas, which is visited by thousands of people from around the world. Likewise, the knowledge acquired enabled the structuring of significant content that enriched the visitors' experience, improving their perception of the place and ensuring a more attractive and meaningful experience.

The implementation of the VLASS virtual assistant proved to be an effective tool to increase visitors' understanding of the historical and cultural aspects of the Sanctuary. The assistant's ability to recognize images and respond with contextualized information facilitated a more dynamic and personalized interaction, as digital technologies enable users to access in-depth knowledge in an immediate and accessible manner.

The findings from this research demonstrate that the application of the virtual assistant at the Sanctuary of Las Lajas has had a beneficial effect on both the tourist experience and the understanding of the cultural and historical heritage of visitors to the Sanctuary. The implementation of virtual assistants is an effective tactic to enhance interaction and learning in tourism contexts, reflecting technology's optimization of the user experience and its propagation of a cultural legacy.

RECOMMENDATIONS

Integrate video processing into the tool

Including video processing in the VLASS virtual assistant would enhance its recognition capabilities, enabling it to identify locations in the Las Lajas Sanctuary based on video fragments submitted by users. Thus, incorporating this functionality expands the current image processing capabilities, making it easier for the assistant to analyze video sequences and identify various components of the environment in real-time. Thus, the assistant could provide more accurate and contextual responses, enhancing the user experience through more vivid and detailed interactions.

Apply Natural Language Processing (NLP) to improve communication

With the help of advanced Natural Language Processing (NLP) techniques, interaction with users would be significantly improved. This upgrade will enable the assistant to understand queries more accurately and naturally, recognizing the purpose of each message without relying on inflexible structures. Consequently, responses will be more meaningful and fluid, providing a more human-like interaction experience and increasing user satisfaction.

Develop analytics functions to improve decision making

Given that Las Lajas Sanctuary is a tourist destination that attracts visitors from different parts of the world, extending the capabilities of the VLASS virtual assistant with multilingual support is critical. It would allow providing answers in several languages, automatically adapting to the user's language according to their preference. This would facilitate interaction with international tourists, eliminating language barriers and providing clear and contextualized information.

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None.

CONFLICT OF INTEREST

None.

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