**ABSTRACT**

ijaunnderer AR: An Augmented Reality-based Gamified Local Tourism and Cultural Heritage Promotion and Preservation aims to add museum setups using augmented reality (AR) technology, and improves visitor experience and remote visiting of museums through a companion website. Its first phase, or exploratory phase features Tarlac and its provincial museum and showcases tourism information for dining, accommodation, heritage sites, and natural spots. The museum, “Diwa ng Tarlac” translated in English as “Essence of Tarlac” was chosen as the host of the scanned artifacts and as the location for the testing for external user acceptance (external UAT). The acceptance test scores were measured using a Likert-type scale and the average score for all screens is 4.23. Thus, to address the comments gathered from the UAT in Diwa ng Tarlac, systems improvement was done and implemented for the final roll-out of the iJuanderer application.

**Keywords**: Augmented Reality, Tourism, 3D Scanning, Cultural Heritage Promotion and Preservation

**INTRODUCTION**

In terms of foreign exchange revenues and employment generation, the tourism sector is among the fastest-growing sectors of the economy. As a result, several developing economies, such as the Philippines, have prioritized the tourism industry (Nazarea-Macandili, 2016).

The Philippines is famous for its biodiversity and cultural heritage. According to the former Philippine Department of Tourism Secretary Mr. Joseph Ace Durano, quoted by Nazarea-Macandili in her presentation for MyEscort (2016) - “The country’s tourism potential is not yet maximized, hence the need to promote the Philippines as a tourist destination haven.”

The traditional approach for finding tourist information is still “manual searching for notable places to go” to “where access to information can be done by hiring an agent; buying a leaflet or brochure; asking friends about the place; or searching the web.” (Nazarea-Macandili, 2016).

Small-time businesses that cater to tourists and travelers may have tight budgets, and advertising may prove to be expensive so AR-mobile-based tourism promotion may cut the cost of marketing and promoting tourist spots or destinations.

A perceived better means of obtaining information about tourist destinations may be accomplished using the presented AR-based tourism promotion application. Knowing the various objects present in each tourist attraction could also contribute to a better knowledge of the Philippine culture and biodiversity. More visibility for tourist sites mostly in the provinces as a result of participating in an AR-based tourism marketing adventure boosts the level of engagement to visit hidden tourist destinations across the country. It’s also mobile, allowing you to communicate with folks on the go. The proposed invention has a lot...
of promise for increasing exposure to previously underserved markets.

Project iJuanderer aims at developing an Augmented Reality based tourism for the promotion of the tourist spots destination, educating the tourists coming from local and abroad about a specific place's heritage and culture. This Augmented Reality application can be deployed on a mobile device for portability. It contains quests for different markers and artifacts for specific tourist spots as well as provides information on where to avail of the best souvenir shops, accommodation, and tour packages. It complements and enriches the existing tour packages by providing a social rewards system. The more artifacts and markers that can be collected and visited, the more points the AR app user can be obtained. The said points may be used to avail discounts to partner merchants.

OBJECTIVES OF THE STUDY

This study aims at designing and developing an Augmented Reality-based Application that employs gamification in promoting the local tourist spots destinations in the Philippines. Primarily, the local tourist spots in the province of Tarlac were used for the testing and evaluation of the proposed application. Travelers' experiences are undoubtedly enhanced by an AR-based tourist application that engages them in learning much about the country's heritage by collecting "collectible" objects and identifying select sites on a list. Specifically, the study aims to ascertain the tourist needs through a design-thinking process approach, determine the effectiveness of gamification in Augmented Reality for tourism promotion, identify the knowledge, hardware, and software requirements needed in the development of the proposed app; and lastly, evaluate the overall effectiveness of the iJuanderer: Augmented Reality-based tourist application.

METHODOLOGY

The study is applied research through the implementation of designed algorithms and processing of the gathered information. The method utilized in the development process is the agile software development model (figure 1). Figure 1 illustrates the different phases and data involved in the development phase. (InfoWorld United States (2020))

![Figure 1. Agile Methodology](image)

AGILE Team Composition - iJuanderer
Project Leader - Joel Bautista
Project Development Officer - Anthony James Vizmanos
AR Developer - Jonathan Mercado Jr.
UI/UX / Graphics Designer - Razel Mari Sta. Rita
Quality Assurance/Tester
Collaborators and Partnerships: Tarlac Province Tourism Office

Requirement Analysis. Research works involving augmented reality-based tourist apps will be studied by the proponents in order to be more knowledgeable on the background of the study. This phase of the development is vital in the design of the study. The right people from the industry were identified.

Design Thinking Approach. Design thinking is defined as a human-centered problem-solving process and is a non-linear, iterative process to learning people, challenge assumptions, redefine challenges, and prototype and test novel solutions. Empathize, Define, Ideate, Prototype, and Test are the five phases that are best used to solve
problems that are not well-defined or unknown. (Interaction Design Foundation, n.d.).

![Design Thinking: A 5-Stage Process](image)

**Figure 2. Design Thinking Process**

Design thinking approach was used by the researchers in digging deeper into the needs of the travelers or tourists needs. A design thinking workshop session with selected participants was done in order to empathize, define problems and ideate/generate proposed solutions from the participants of the workshop.

**Prototype Development**

*Design.* The application was designed based on the design-thinking approach to tourist needs. This step also includes determining the overall software architecture of the app.

*MATERIALS.* For the materials to use, comprises the software requirements, the hardware requirements, and the data requirements to create the system.

**Software**

Table 1 exhibits the software requirements needed to develop the information system languages and tools considered for the system. The PHP was used to capture information from the iJuanderer user. Then it was saved on the database for future retrieval and access.

**Hardware**

Table 2

<table>
<thead>
<tr>
<th>Part</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network/Internet Connectivity</td>
<td>Wired/Wireless</td>
</tr>
<tr>
<td>Mobile Phone</td>
<td>With AR support</td>
</tr>
<tr>
<td>High-End Desktop/Laptop</td>
<td>With Unity 3D installed for development</td>
</tr>
<tr>
<td>3D Scanner</td>
<td>For scanning physical artifacts for virtual reality assets conversion</td>
</tr>
</tbody>
</table>

The hardware requirements listed in Table 2 depict the hardware considered for the development and implementation of the study. The system developed is online with mobile responsive features for ease of access to the users. The mobile phone used in testing and deployment of the system is the Nougat version to further explore the compatibility issues with other versions.

**Data Sampling.** The project aims to generalize a conceptual design for the public because the AR-based tourism program can be used by the general public. It is not realistic to apply the optimization method to an entire population, but it is feasible to apply it to an individual and afterward generalize it to a community. The researchers used an inferential approach to validate the generalized solution, ensuring that it matches the needs of individuals within a pre-defined "error tolerance". A purposive convenience sampling was utilized in the evaluation of iJuanderer. Volunteers were recruited to participate during the evaluation/testing process. A collaboration with the Tarlac Province Tourism Office was established.

**User Acceptance Using Technology Acceptance Model (TAM)**

The researchers used the user acceptance model to assess the performance, functionality, and design of the system. There were 30 participants who will evaluate the system using a questionnaire based on the developed TAM model.
The factors considered were the usability, functionality, and complexity of the system.

![The Developed TAM Framework](image)

The external variables considered in the study were computer self-efficacy and system complexity. The following hypothesis was derived to evaluate the TAM model used.

**H1:** Computer self-efficacy has a significant consequence on the perceived usefulness of the information system.

**H2:** Computer self-efficacy has a significant consequence on the perceived ease of use of the information system.

**H3:** System complexity has a significant consequence on the perceived usefulness of the information system.

**H4:** System complexity has a significant consequence on the perceived ease of use of the information system.

**H5:** Perceived ease of use has a significant consequence on the perceived usefulness of the information system.

**H6:** Perceived ease of use has a significant consequence on attitude toward using the information system.

**H7:** Perceived usefulness has a significant consequence on attitude toward using the information system.

**H8:** Attitude toward using has a significant consequence on the intention to use the information system.

**Data Gathering.** The team visited “Diwa ng Tarlac” last November 13, 2021, to conduct a user experience survey to the visitors of the museum. A total of 21 respondents participated in the activity led by the Project Leader together with the Project Development Officer and AR Developer. The activity started with the installation of the application (using an APK file) to the participants’ mobile devices and orientation on how to scan artifacts. Several scannable QR codes were scattered around the museum for the participants to scan using the gamification feature of the iJuanderer application. Upon completion of the game, the participants were then asked to answer an online survey on their experience using the application.

![Figures 4 – 6. Participants of the iJuanderer v2.0 Application Evaluation while using the application in Diwa ng Tarlac](image)

![Figure 7. Participants of the iJuanderer v2.0 Application who completed the gamification feature of the application within the time limit.](image)
RESULTS AND DISCUSSION

1. Regional Distribution of Overnight Travelers in Accommodation Establishments (CY 2019)

   Tourism is one of the important sectors that contributes to national economic growth. According to the Philippine Statistics Authority (PSA) in 2018 it contributed 12.7 percent of the Gross Domestic Product to the Philippine Economy. Data from the Philippine Department of Tourism in Table 3 below shows the number of tourists, both foreign and domestic, coming to Region III or Central Luzon for a short vacation from January to December 2019.

<table>
<thead>
<tr>
<th>Region/Province City</th>
<th>Foreign Travelers</th>
<th>Overseas Filipinos</th>
<th>Domestic Travelers</th>
<th>Total 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region III (Central Luzon)</td>
<td>672,372</td>
<td>3,367</td>
<td>3,410,635</td>
<td>4,086,374</td>
</tr>
<tr>
<td>Aurora</td>
<td>162</td>
<td>273,744</td>
<td>273,906</td>
<td></td>
</tr>
<tr>
<td>Bataan</td>
<td>11,034</td>
<td>386,815</td>
<td>397,849</td>
<td></td>
</tr>
<tr>
<td>Bulacan</td>
<td></td>
<td>149,171</td>
<td>149,171</td>
<td></td>
</tr>
<tr>
<td>Nueva Ecija</td>
<td>13,959</td>
<td></td>
<td>302,771</td>
<td>316,730</td>
</tr>
<tr>
<td>Pampanga</td>
<td>411,154</td>
<td>499,512</td>
<td>910,666</td>
<td></td>
</tr>
<tr>
<td>Clark</td>
<td>391,457</td>
<td>330,110</td>
<td>721,567</td>
<td></td>
</tr>
<tr>
<td>San Fernando</td>
<td>6,599</td>
<td>122,957</td>
<td>129,556</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>13,098</td>
<td>46,445</td>
<td>59,543</td>
<td></td>
</tr>
<tr>
<td>Tarlac</td>
<td>14,796</td>
<td>646</td>
<td>93,264</td>
<td>108,706</td>
</tr>
<tr>
<td>Zambales</td>
<td>76,644</td>
<td>773,596</td>
<td>850,240</td>
<td></td>
</tr>
<tr>
<td>SBMA</td>
<td>98,861</td>
<td>907,731</td>
<td>1,008,630</td>
<td></td>
</tr>
<tr>
<td>Angeles City</td>
<td>45,762</td>
<td>24,031</td>
<td>70,476</td>
<td></td>
</tr>
</tbody>
</table>

Source: Tourism Demand Statistics, Statistics, Economic Analysis and Information Management Division, Department of Tourism

As perceived in Table 3, Tarlac got the smallest number of tourists compared to other provinces within the region (not counting the independent cities such as Angeles City). Despite Tarlac being the melting pot of Central Luzon, the historical landmark of the historical Death March, and the home of many artists and especially the locale known for its pottery, it did not translate to increasing its tourism potential. Efforts to boost the tourism of Tarlac need further push, and potential activities, especially using the technologies of the internet and mobile connectivity/communication may be utilized to further attract visitors into coming to the province.

2. Promotion of Tourism Industry in the Philippines

2.1. Slogan

Various efforts have been made to promote the tourism industry in the Philippines. The slogan “It’s more fun in the Philippines” as well as engaging tourism ambassadors were done to boost the country’s tourism. To convey the Philippine tourism industry, an AR-based mobile application will be developed.
2.2. Mobile Devices

For everyone, mobile devices have now become a need for communication and information sharing. Augmented Reality is a visualization and simulation application that is now being utilized in the media to promote items, whether they are commodities or services. In earlier tests, respondents were particularly intrigued by Augmented Reality since they could see a sampling of a product they wanted to buy and interact with it immediately through their cellphones (Sasfitri, et. al., 2015). Augmented Reality (AR) has been shown to improve motivation in educational settings such as Experiential Learning and Gamified Learning. One of the most sought-after applications in tourism is augmented reality, which has a big potential to improve passengers’ experiences. Knowledge, travel, tutorials, and translations are all available through AR smartphone apps.

2.3. AR technology

As a prominent tourist attraction, the country is noted for its diverse biodiversity. Its beaches, historic cities and monuments, mountains, jungles, islands, and diving locations are among the country’s most prominent tourist attractions. The Philippines’ rich heritage legacy, including festivities and cultural beliefs, is one of the country’s main draws.

Travelers’ experiences will undoubtedly be enhanced by an AR-based tourist application that engages them in learning more about our country’s culture by collecting "collectible" objects and putting select sites on a list. The artifacts and exhibitions will be scanned using 3D scanning technology, which may aid in the preservation and allow access to individuals who are not able to actually see the objects shown.

3. Summary of drivers and bottlenecks in the adoption of AR

In recent research conducted by Martinez group (2014), it recognized the rising recognition of the utilization of Augmented Reality for academics and business practitioners. In spite of the several studies on the benefits of AR, it was noted from their research that AR hasn't achieved its full potential yet due to various bottlenecks and hindrances to its successful adoption.

The drivers and obstacles of AR acceptance and spread in five primary application domains: (a) industrial and military, (b) education
and training, (c) travel and leisure, (d) medicine, and (e) commerce and marketing.

Table 4
Summary of drivers and bottlenecks in the adoption of AR

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Bottlenecks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost can be reduced by using AR in several manners (e.g., reducing errors in manufacturing processes, reducing errors, safety procedures, etc.)</td>
<td>No standardized AR application's functionality</td>
</tr>
<tr>
<td>Fast learning curve</td>
<td>The technology is intuitive and easy to use. Therefore, the adoption from novices is easier than in other technologies.</td>
</tr>
<tr>
<td>Customity</td>
<td>The idea of &quot;expanding&quot; the real environment with virtual content usually catches the attention of users that feel tempted to use the applications.</td>
</tr>
<tr>
<td>Tangible (3D) visualization</td>
<td>Visualization of 3D content in real life and the possibilities of interaction offer an added value.</td>
</tr>
<tr>
<td>Fun</td>
<td>The technology offers a component of fun in many cases that can be useful in several fields (especially in education and tourism).</td>
</tr>
</tbody>
</table>

A cross-domain comparison is facilitated by such an overview, which allowed us all to recognize a list of five contributors and five roadblocks in the adoption of current AR technology. Table 4 presents a summary of the drivers and bottlenecks analyzed in their paper.

4. Profile of the Participants

4.1. In terms of Age

![Age Range of Evaluators](image)

Most of the respondents have an age within the “18-25” range. Followed by the “25-40” years old.

4.2. In terms of Gender

![Gender Distribution of Evaluators](image)

Twelve (12) or 57.1 percent of the respondents are female while there are nine (9) respondents are male.

5. Application of Evaluation Scores

![Likert-type Scale of User Acceptance Scores](image)

Among the participants, the common and significant comments and suggestions were as follows:

- The application is not working on some mobile devices, specifically RealMe devices, Samsung A51s, and Oppo A5s. If ever the application loads in these devices, the camera function is either not working or
the QR codes are out of focus and cannot scan properly;
- The application is heavy to download (the iJuandererAR v2.0 is 360MB);
- The respondents want to see “achievement” features such as a page where they can see games that they won and “medals” that they can see if they are able to visit a specific place that is featured in the application;
- The respondents wanted to have a complete feel of the artifacts on their completeness and would want to see optimized versions of the artifacts;
- Some respondents wanted to see a cleaner homepage, less buttons, and labels on the buttons as some got confused about what the buttons are for. Some commented they wanted to see a guide on how to use the application;
- Some respondents want trivia about the places and the artifacts. They also like to have better AI audio than the current text-to-speech interface;
- Majority of the respondents would like to see these artifacts even when they are not on-site to scan QR codes.

6. Application Design

The iJuanderer AR v2.0 currently has these in the home screen:

![Figures 14 - 16. Homepage screens of the iJuanderer v2.0 Application displaying Museums, Hotels, and Other Tourism Information respectively](image)

The iJuanderer AR v2.0 currently has these on the artifact scanning (information) page:

![Figures 17 - 18. Sample information screens of the iJuanderer v2.0 Application when clicking on a specific tile under the homepage categories (shown above are for hotel and other tourism information pages respectively).](image)

The image on the left shows the image upon initial camera focus and the image on the right shows the artifact description upon clicking on the button.

To address the transparency and hollowing issue of the initially scanned artifacts, the AR
Developer manually optimized the images to remove the issues detected.

Figure 21. Screen capture of the artifact optimization process done by the AR Developer to address transparency of an initially scanned 3D image.

The optimization effort turned the artifacts into more solid images which were incorporated into the iJuanderer v2.1 (optimized artifacts shown below).

Figures 22-25. Optimized 3D image rendering of the initially scanned 3D images of the artifacts from Diwa ng Tarlac.

7. Gamification

The game feature was tested in Diwa ng Tarlac with the following mechanics:

- There is a total of eight (8) QR codes with artifacts that were scattered around the museum. Four of the artifacts are actual museum pieces from Diwa ng Tarlac (of which the QR codes are displayed on the information counter) and the other four (4) are just random artifacts generated by the AR Developer. To win the game, the four artifacts from the museum must be scanned and have the button pressed to enter as a point. If the participant pressed the button at the wrong artifact, they will have a timer deduction. The participants were given three (3) minutes to find all the right artifacts to win the game. The in-game timer included the three-minute countdown.
- In this version, only Level 2 is activated.
- Game screenshots:

![Game screenshots](image-url)

8. Companion Website

To address the respondents' suggestions of being able to scan artifacts using their mobile devices at home, a companion website was developed and published. This includes the Diwa ng Tarlac whose artifacts are featured in the iJuanderer application, and the QR codes that were featured in the on-site testing were uploaded and embedded to the page dedicated to the museum. The companion website can be accessed through [www.ijuanderer.com](http://www.ijuanderer.com) and screenshots of the website can be seen below.

![Companion Website screenshots](image-url)
CONCLUSION

The iJuanderer AR project supports the cultural and heritage promotion and preservation of Philippines provinces. The AR feature of iJuanderer acts twofold: as a technological appendage to the ordinary setup of a museum and as a remote museum that users can explore without having to travel. The technological appendage feature of iJuanderer can help reduce human interaction within the museum through the use of QR artifact information generation and narration can help the tourists get their tour guides without the need of an actual tourist guide, providing enhanced social distancing and reduced human contact that will help prevent the spread of the COVID-19 infection. The remote exploration feature of iJuanderer, on the other hand, gears towards pandemic-resilient tourism promotion where provinces can continue to spread cultural and heritage knowledge of their locality without the risk of acquiring COVID-19 from exploring outside.

RECOMMENDATIONS

Given the time and resource limitations of the project, the following recommendations were suggested to further improve the project and expand the use of the iJuanderer application:

1. Utilize the narration of the dioramic displays inside the museum and reduce the need for an actual museum guide to verbally narrate the stories behind the displays.
2. Expand the iJuanderer project to several more provinces that can be considered low-lying fruits. This can help in the cultural and heritage promotion and preservation of provinces that are lesser-known to the common traveler.
3. Explore the technological transfer of the project to the tourism sector to pass the 3D scanner around provinces that need assistance in tourism promotion, scan their local artifacts, and input all information and 3D images in the iJuanderer application.

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Anthony James Vizmanos, is the Project Development Officer I of the Project iJuanderer AR. He is now working at the Department of Education Division of San Juan City. He is a Food scientist, microbiologist, and hygienist. He also specializes in data science, stewardship, and analysis. He is Certified on Six Sigma Yellow Belt and trained in Lean Six Sigma Green Belt.

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