User Experience Guidelines of Augmented Reality Application for Historical Tourism

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Abstract— **Malaysia Smart Tourism 4.0 is a government initiative that aims to transform the tourism industry to the next level. Tourism 4.0 is the next generation of the tourism industry that uses the latest industrial revolution technologies such as Augmented Reality (AR). AR is a new technology that uses computer graphics to create the illusion of being in the real world. In recent years, the Mobile Augmented Reality (MAR) approach has been used in many sectors such as tourism, education, and healthcare. User experience is crucial for MAR applications since it attempts to meet the user's needs and enhance engagement. However, limited studies on user experience in historical tourism have been explored due to the lack of evidence and empirical research. Thus, this study is to propose user experience guidelines for an Augmented Reality application for historical tourism. More than 60 articles related to AR in tourism were analyzed using thematic analysis in this study. The study resulted in two findings: (1) the user experience guidelines of Augmented Reality for historical tourism applications, and (2) user experience that was influenced by the application features and the requirements of tourists. The findings will be used to propose an UX design for MAR applications in the context of historical tourism. Most significantly, the number of successful deployment use cases for MAR applications is currently limited, especially in the tourism industry. Thus, it is critical to have a comprehensive set of variables has been considered for success.**

Keywords— **Augmented reality; mobile application; historical tourism; AR guidelines.**

I. INTRODUCTION

In many nations, the tourism industry is recognized as one of the most important contributors to global financing [1]. Malaysia is recognized as one of the world's top tourist destinations, and the tourism industry contributes significantly to the country's economic development. The tourism industry has the potential to be a major economic driver for a country, particularly for developing nations aiming to diversify their revenue streams [2]. The tourism industry has also been acknowledged as one of Malaysia's major economic growth contributors [1]. As a step forward in implementing smart tourism, Tourism Malaysia has launched Malaysia Smart Tourism 4.0, which aims to increase digital technology and its impact on travel demand and tourism-related enterprises, particularly among tourists [3]. The Malaysia Smart Tourism 4.0 initiative aims to take the tourism industry to the next level by utilizing digital potential [3]. In addition, Tourism 4.0 is a project focused on creating an ecosystem that enables tourism stakeholders to collaborate

in developing a more interactive and immersive tourist experience using the Fourth Industrial Revolution, such as AR [1]. AR is a new technology that allows users to interact with virtual things in a real-world setting [4]. In AR, the user is presented with a realistic and real-time view of the world with artificially augmented information using various computer systems such as texts, images, videos, and audio [5]. AR enriches the real-world environment by overlaying computer-generated content (e.g., avatars, 3D models, interactive features) onto users' direct view through a device, providing context-sensitive information about their immediate surroundings [6].

AR has been used in the tourism industry. Augmented reality technology has changed the tourism sector over time [7]. AR has the potential to improve travel experiences by delivering meaningful information and knowledge about tourism sites that users are planning to visit and offering a level of user entertainment [8]. As cited by tom Dieck and Jung [9], the potential benefits of utilizing AR to improve the tourist experience are growing as more tourists use mobile devices. Despite the recent advances in AR, there is still

limited study of user experience conducted in the context of tourism [9]–[11]. User experience is subjective and a context-dependent domain [12]. It has been observed that the emotions that users experience before and after using a product are also changed as their perception changes [13]. User experience considers the entire user-product interaction, including product use and consumers' meaning and emotion from their encounters with items [14]. Promoting a good user experience is critical to an application's success and acceptance, as a fascinated user may want to repeat the engagement [15].

This study aims to develop a user experience guideline for augmented reality applications for historical tourism. AR technology has the potential to transform tourist engagement into a better digital tour experience. The next section is a literature review that explains AR applications, user experience, thematic analysis, and card sorting.

A. AR Application

Within the field of tourism, there have been attempts to create AR-based applications for the past few decades. AR can improve the tourist experience by assisting travelers in accessing important information, hence boosting their understanding of the tourist location while also enhancing the levels of user entertainment [5]. The key advantage of AR is that it provides consumers with a massive visual experience. AR aims to meet users' needs for real-time digital representation of information by augmenting and visualizing it in their physical surroundings. It enables real-time access to rapidly flowing data, mainly at the appropriate moment and in the proper space [16]. AR is a technology that overlays computer-generated upgrades on top of a real-world environment to make it more appealing by allowing users to interact with it [17]. By overlaying virtual content such as text, image, audio, or 3D models on real-world views, Augmented Reality (AR) provides more than what consumers see every day [18]. As cited by Yovcheva et al. [19], the emotion, feelings, knowledge, and abilities that emerge from the perception, processing, and interaction with virtual information that is integrated with the real physical world surrounding the tourist are defined as augmented tourism experience, arguing that the topic of expected and real experiences from using AR technology in the context of tourism is still not sufficiently studied [5].

The ultimate goals of AR applications are to provide improved management and accessible access to information through seamless strategies that merge the real interactive world with an interactive computer-generated world to create a single cohesive environment [20]. Besides that, AR could help tourists find their way around a new place, but with an interactive and helpful way to navigate [17]. The use of technologies like augmented reality (AR) can improve visitor intent (pre-visit), give richer information and analysis (on-site), learning and enjoyment (on-site), and higher spending and intention to return (post-visit), all of which improve the tourist experience [21]. As cited by Garau [22], AR apps can now improve tourist experiences by overlaying digital information available via smartphone displays in the real world while preserving the site's original state and raising awareness about heritage preservation [1]. In a study conducted by Koo et al. [23], they developed a mobile tour application using AR technology where user experience and the application's ease of use were considered for the Hwaseong Fortress. The study used AR interaction and visualization technologies to create a complete set of device-guided tour applications for heritage sites [23]. Khan et al. [24] developed an Augmented Reality (AR)-based smartphone application to augment users' museum experience with relevant multimedia content and build a better connection with the artifacts for Pakistan's Taxila Museum to preserve Gandhara culture. Siang et al. [1] developed a mobile AR application to investigate elements that influence museum visitors' behavioral intention to use the application. The study showed that AR makes history more immersive and engaging for museum visitors, fully appreciating local culture and traditions [1]. To improve client experience and reduce the number of human tour guides at the Egyptian museum, Hammady et al. [25] developed an alternative tour guidance system. Malca et al. [26] developed an innovative technique to assist tourists in Riobamba in a modern way, using Augmented Reality technology through an AR-TOUR application. AR-TOUR is a mobile service platform that will present the city of Riobamba's principal tourist attractions, such as churches and parks, in 3D, increasing tourists' interest in visiting locations and making navigating through the city easier [26].

B. AR User Experience

Many recent studies examine user acceptance of mobile AR applications in tourism to determine how new technological breakthroughs are accepted [1], [27]. However, there is still limited user experience study conducted in tourism [9], [10]. User Experience (UX) is a person's perception and response as a result of using or considering using a product, system, or service [9]. ISO defines user experience as "a person's perceptions and responses as a result of using and/or anticipating using a product, system, or service." [11]. It is critical to understand which features affect the total user experience because depending on product attributes like ease of use has shown to be insufficient [9]. The physical qualities of mobile devices should be considered while creating the interface and design aspects to allow the user to obtain the information they require [26] quickly. From the standpoint of business owners, they aim to receive indications and instructions that will increase clients' propensity to return to these services. As cited by Garret [28], the characteristics of user experience (UX) might be particularly helpful for business operators among the numerous guidelines on offering services [29]. Good user experience is a very important factor in designing products due to continued use and increased customer loyalty [9]. It is difficult to predict the user experience. As a result, thematic analysis is utilized to determine the application's theme [30], and a card sorting technique was conducted to organize the theme into appropriate classification [31].

C. Thematic Analysis and Card Sorting on AR Application

Thematic analysis is a process used to extract meaning and concepts from data [32]. This procedure involves analyzing and recording patterns and themes in a data set. It is also a technique for discovering patterns in data collection and providing comprehensive interpretations of different parts of

the data set on the research topic [32]. In a study conducted by Han et al. [9], thematic analysis was used to analyze the themes' alignment with previously identified issues in the literature as well as to produce new emerging themes from the focus groups. In a similar study, the thematic analysis was used, which revealed seven variables that should be included in the AR acceptance research of the tourism context [33]. Card sorting is an empirical method used to study the mental model of a concept or domain of a concept [31]. It is a standard research tool that is used by the information architect and usability experts [34]. Its goal is to collect and analyze user data. Card sorting is a technique to design or evaluate a site or application information architecture [31]. Participants classify issues into categories that make sense to them during a card sorting session and assist in labeling these groups. Card sorting has been used to analyze data in AR research, particularly [35]. Card sorting is frequently cited as an effective research technique for assuring content navigation and findability within an information system and influencing design with a user-centric perspective [36]. The method of this study will be explained in detail in Section 3.

II. MATERIAL AND METHOD

This section describes the method used in this study. A comprehensive and systematic literature review on AR was conducted to retrieve and gather all the studies related to tourism. There are three stages of filtering and analysis used in the literature review stage. The first stage retrieved articles from Google Scholar, Science Direct, IEEE Xplore, Scopus, Springer Link, ACM Digital Library, and Research Gate between 2016 and 2021. The primary search keyword used was "Augmented Reality application for tourism" or "Augmented Reality Tour Guide application". As an alternative, search keywords "Augmented Reality", "tourism", "tour guide" were used to search further articles. All the keywords were taken from journals, textbooks, technical reports, and conference proceedings.

The first 65 articles in each search engine result were studied, and those that seemed relevant in terms of Augmented Reality and tourism were chosen. At this stage, the studies proposing AR applications in the context of tourism and review articles were accepted. In the second stage, the articles were reduced to 45 which were related to AR tour guide applications. 45 articles were analyzed in-depth to investigate the application design in the third stage. This was an iterative process, and the analyzed articles were revisited, focusing on the design of the AR tour guide application. In total, 28 articles were selected for critical examination and made it to the results table.

After the search, the 28 articles that were chosen were analyzed using card sorting and thematic analysis. Prior to the complete system design, card sorting was discovered to be a highly effective and important approach to getting user input for organizational categories [37]. Cards were prepared to carry a design description. Thematic analysis is a framework that draws on previous literature to identify and develop new themes [9]. The key element of data analysis that generates practical outcomes in the field of research is called a theme [32]. The data were clustered thematically from the literature review. For the first analysis, the structure of the themes

discovered from the literature review was content, design, and outcome, as seen in Figure 1.

Fig. 1 An iterative process in developing themes: Content (green), Design (Orange), Outcome (Pink)

In the second analysis, the themes were expanded with more sub-themes. For content, it was refined to context, 3D models, navigation, customization, language, rating, multimedia information, tutorial, and personalization, as shown in Fig. 2. For the design theme, the sub-themes formed from the analysis were user interface (UI), graphics, and aesthetics, as seen in Figure 3. Lastly, the outcome was feasibility, detailed to user experience outcome, accessibility, aesthetics, and usability, as shown in Figure 4. The emerging themes from the analysis are discussed in detail in the results section.

Fig. 2 Sub-themes for content

Fig. 3 Sub-themes for design

Fig. 4 Sub-themes for outcome

III. RESULTS AND DISCUSSION

In continuing the AR research, the user is frequently excluded from the system design process, and user interface design principles are rarely acknowledged in the development process [38]. User experience (UX) is a term that refers to the main quality factors of any product, system, or service that is designed for human use, as well as indicators of the success or failure of a product, system, or service [39]. Therefore, it is important to identify suitable elements in an application while considering user experience. From the analysis conducted, the design guidelines for the user experience of the AR tour guide application were divided into two elements, namely AR content and AR features. Table 1 presents the list of categories for AR content elements with references. There were six content elements of the AR application found in this study: (1) 3D, (2) Point of Interest (POI), (3) Text, (4) Image, (5) Audio, and (6) Video. This section describes the method used in this study. A comprehensive and systematic literature review on AR was conducted to retrieve and gather all the studies related to tourism.

TABLE I
AUGMENTED REALITY (AR CONTENT ELEMENT)

Category	References
3D	AR technology can improve the visitor experience by allowing visitors to see 3D representations of available collection artifacts, making them feel more engaged and able to increase visitor numbers, particularly among youngsters and students, compared to when there was no AR technology. [40]
	3D interaction should be compatible with a variety of mobile devices - the virtual and actual object designs should match, and the 3D interaction's functionality on various devices should be evaluated. [8]
	The 3D model's high accuracy helps participants remember their current location and the locations of various points of interest they've visited. [41]
Point of Interest (POI)	The purpose of the mobile tour app was to create tourism guide software that simply allowed visitors to navigate in the area of interest (site-specific

	feature) and provide multiple items connected to POI to fulfill spot-specific features using AR components. [23]
	The mobile AR guide provides information about nearby Points of Interest (POI) to users who are on the move. [17]
	Points of interest (POI) that are annotated on a smartphone screen offers great benefits to mobile tourism. Points of interest (POI) can be highlighted by overlaid icons and help users negotiate unfamiliar cities. [42]
Text	By incorporating multimedia elements such as text, audio, and video into AR, the clarity of the information to be transmitted from the presented items can be improved. [4]
	Some users proposed adding text to the application to better convey its function and provide additional historical information about the location. [43]
	The text should be readable despite user interactions, particularly object rotation. The purpose of the textual information accompanying the object on the scene is to describe the object displayed briefly. [44]
Image	When the user visits tourist destinations, the user opens the camera via the mobile application to view 3D images and point the camera at various objects at the actual locations for a more enjoyable tourist experience. [45]
	Historical information in the form of text and images help visitors document their visits. [46]
	Learners used multimedia material about a historic site, such as images and text, to effectively contextualise (that is, physically and socially situate) the current version of the location with the past. [47]
Audio and Video	Users with visual impairments benefit from audio and video support because it allows them to access information through other senses. [9]
	The typical MAR consists of textual data, 3D and still images, but applications that combine additional components like audio and video can encourage human-computer interaction. [8]
	Text, video, audio, animation, and photos are examples of multimedia material that the viewer can interact with while touring the museum. [34]

First, the content element of AR is required to be represented in 3D. The characteristic of a 3D model is needed to have detailed modeling for the interaction of any historical building. When visitors are able to see 3D representations of available collection artifacts, AR technology can improve the tourist experience, making them feel more involved and increasing visitor numbers, especially among youngsters and students, compared to when there was no AR technology [40]. In another study, Ocampo [8] recommended seamless 3D interaction in various mobile platforms to cater to virtual and real objects. Andri et al. [41] conceded that the high precision of a 3D model enables users to visualize where they are positioned and the locations of various points of interest in their chosen region. Therefore, 3D models for AR need to be created in high- quality and contain 3D interaction.

Next, displaying information about Points of Interest (POI) and the surroundings is one of the important functions of an AR tour guide. In addition, it provides guides to navigate people in the area of interest. Points of interest that are

highlighted on a smartphone screen using AR tags or icons can help users navigate foreign cities. Koo et al. [23] stated the goal of an AR application was to provide a comprehensive guide software that lets users navigate in a specific area of interest and also introduced various features related to POIs. The mobile AR guide can allow consumers on the go information about nearby Points of Interest (POI) [17]. Moreover, Williams et al. [42] recommended POI displayed using tags or icons in the AR camera view offers an advantage to mobile tourism, such as assisting in providing POI information and helping users navigate foreign cities. Hence, a mobile AR application that includes POI information and visualization of POI annotation with icons on the camera view can easily assist users in navigating foreign cities.

Other than that, AR that is represented with text benefits the user as it displays more information. Text information is necessary to have a suitable and easy-to-read font. The clarity of the information sent from the exhibited things can be improved by combining multimedia elements such as text, audio, and video into AR [4]. Similarly, Boboc et al. [43] stated that some users proposed adding text to the application to better convey its function and provide additional historical information about the location. The text font should be readable and provide a brief description of the object shown, as Krainyk et al. [42] stated. Consequently, text information in AR applications should be represented with readable and uncomplicated fonts.

Besides that, images with text descriptions demonstrate a better understanding of AR content to the users. The high-resolution images with simple and easy-to-read text font represent historical AR information better. Phithak and Kamollimsakul [45] stated that 3D images allowed users to visit a tourist attraction with a more delightful tourist experience. In a similar vein, Panou et al. [46] recommended using images with text to explain the details of historical information. In another study by Wong [48], it was suggested that an image with high resolution is able to provide a better reasonable experience and satisfaction for users. Therefore, image content for an AR must be provided in the form of higher resolution with a text description.

The last category for the content element is audio and video, which is where the compatibility helps visually impaired users receive information in a variety of ways. An augmented guide is an advantage because it provides the user with textual, audio, and video content on the cultural site, and it saves the user time and effort while also protecting the environment. Han et al. [9] stated that audio and video support could help people with visual impairment to receive information. Moreover, Ocampo stated that MAR, combined with other components like audio and video, is able to enhance human-computer engagement [8]. In another study, Young and Santoso [34] conceded that users could get some experience while exploring the site with the aid of text, video, and audio information. As a result, audio and video information in AR could help visually impaired users and provide some experience to users.

The second element identified in this study was AR features. Table 2 shows the list of categories for AR features element with references. The AR features element was divided into six categories which are: (1) Rating, (2) Navigation, (3) Language, (4) Tutorial video, (5) Personalization, and (6) Customization.

TABLE II
AUGMENTED REALITY (AR) FEATURES ELEMENT

Category	References
Rating	Users can use rating functions to share and receive an overview of viewable tourist places, which is quite valuable for tourists. [9]
	According to their ratings of touristic areas, two categories are identified as user's favorite places and least favorite places. [49]
	An extra social media element, such as rating the POI, could be added to the application to make it more engaging by allowing other users to suggest it to others. [17]
Navigation	Using navigation arrow icons, the system shows the landmark's name within a radius of where the user is standing. Users explore and navigate a location using mobile AR navigation by interacting with their environment. [45]
	Tourists can be guided to walk while collecting information about POIs using AR features, and the destination can be highlighted. The direction arrow is placed on a live video from the device's rear facing camera and the distance to the next POI. [23]
	The ability to navigate to a POI using useful 3D and multimedia navigation information for a rich experience. [50]
Language	To meet the needs of museum visitors from different regions, AR mobile applications should deliver exact, appropriate, and up-to-date information to users in multiple languages. [1]
	The application should be available in most common languages in order to be widely accepted and this is supported by Han et al. (2014); the importance of multiple languages is to enhance user experience. [33]
	Multiple language functions would not only support the implementation in many places, but it also allows tourists to get essential information without dealing with foreign language barriers. [9]
Tutorial Video	To assist tourists who may be difficult to adapt new technologies, tutorial videos were created in the built application. [23]
	Before using the app, the participants were given instructions on using it (a first-use tutorial). [17]
	An interactive tutorial detailing the application's controls should be included right into the application. [51]
Personalization	Personalize quick serve as an advanced search based on specific criteria type that tourists can add or a historical log that will make recommendations based on priorities, popularity, and pricing after typing specific phrases. [34]
	Respondent stated that the applications must be comprehensive and specific; it indicated the necessity for personalization of mobile AR applications. [52]
	It is essential to personalize information by adjusting it to specific interests and sharing

	rating functions to obtain an overview of visible tourism destinations. [9]
Customization	Tourists will have a better experience if they can tailor the application to their preferences, as they will choose POIs or features directly based on their preferences. [23]
	The MAR experience personalization to each user increases by allowing the user to customize the application or automatically adapt the application based on the user's context and preferences. [10]
	Apart from the compulsory presentation of customized information, the user can opt out of irrelevant information and block certain things. [9]

Firstly, the rating features in AR applications are convenient for users because it clearly shows useful tourist spots. Rating features with the share and feedback functions can provide sufficient information as tourists can plan their journey according to the interests and values of each POI. Han et al. [9] stated that it would be valuable for tourists to get functions for overviews of the attractions and sharing via the rating features. Suggested that two groups are determined based on their ratings of touristic areas: user's favorite sites and user's least favorite places [49]. In addition, Ramos et al. [17] recommended that a social media component, such as a rating system for the POI, could be added to the app to make it more engaging by allowing other users to recommend it to others. Accordingly, the rating element is needed to rate, share, and provide feedback comments for users to gain enough information.

Secondly, AR navigation allows users to define routes that best satisfy their needs and interests. The navigation needs to have a real-time video with arrow directions and distance to the next POI while collecting information through the AR features. Phithak and Kamollimsakul [45] stated that users use mobile AR navigation to explore and travel to a location by interacting with their surroundings. The system also displays the landmark's name within a radius of the user's standing when the navigation arrow is pressed [45]. On the other hand, Koo et al. [23] suggested that AR allows tourists to easily navigate around a POI using its built-in features, which display a direction arrow superimposed on a real video. This is also supported by Wang [50], that this feature allows users to navigate to a POI with AR visualization and provide a rich experience. Hence, navigation should be represented in a real-time video displaying the distance to the next POI and arrow directions for a better user experience.

Besides that, AR mobile applications with accurate and up-to-date information should be represented in multiple languages to accommodate visitors' needs from different countries. The variety of language options in AR applications allows tourists to understand the information without struggling with language barriers easily. Siang et al. [1] stated that information in multiple languages in AR mobile applications is needed to cater to the needs of foreign tourists. Similarly, tom Dieck and Jung [33] suggested that the application should be widely accepted in most common languages to provide a good user experience. Han et al. [9] conceded that the application with various language functions would easily allow tourists to access necessary information in

various destinations. Thus, the language in AR applications must be in various languages to provide information for tourists without any language barrier problems.

On the other hand, a tutorial video equipped with the application can help cater to tourists who are reluctant to use new technologies. The tutorial video should be interactive and illustrate how to utilize the AR application before using the application. Koo et al. [23] stated that tutorial videos would help tourists adopt new technology. Similarly, Ramos et al. [17] suggested providing a tutorial on using the application. Stoelák et al. [51] recommended a simple interactive tutorial to accompany the application's controls. Therefore, a tutorial video is required in AR applications to aid tourists in adopting new technology.

Next, personalization in an AR mobile application is important to cater to the different types of tourists. One of the most important components of the personalization ability is to provide tourists with attractions they would be more interested in visiting. Young and Santoso [34] stated that personalization benefits users by giving suggestions according to user preferences and log history. Yin et al. [52] concluded that it is significant to have personalization features because each user's need is different. Other than that, Han et al. [9] recommended presenting personalized information by tailoring the information to personal interests. Hence, the personalization element is required in mobile AR applications to provide suggestions according to users' personal added criteria.

Customizable applications can enhance the tourist experience by allowing the user to customize the features and POI of the application. The customization element would be an option to opt out of irrelevant information. Koo et al. [23] stated that customization enables users to choose POI or features and improve the tourist experience. Likewise, Dirin and Laine [10] suggested that each user's personal experience when using MAR increases by allowing them to customize the application or automatically adapt it based on their context and preferences. Other than that, Han et al. [9] suggested allowing opt-out from collecting and storing personal information in AR mobile applications. Thus, customization is required to enable users to opt-out of irrelevant information. The next section is a discussion of this study.

The design principles improved the development concerns by focusing on the user's perspective, resulting in a better user experience. Therefore, the application design is very important to create a better user experience. From the previous study, three system or product features emerged from the findings: Pragmatic, Hedonic and Consequences. Each of these elements will be discussed in this section. Figure 5 shows the user experience model of the AR application for historical tourism generated from this study.

The user-product relationship is an ongoing process. When a consumer perceives a product's features (the process's input), the result is the system/product's character. A user's description and summary of product features are referred to as system/product characters which consist of pragmatic, hedonic, and consequences. A study conducted by Hassan and Galal-Edeen [39] stated that there are two aspects to a product's characteristic: pragmatic and hedonic. Pragmatic attribute (also known as pragmatic perception) refers to a

product's ability to meet the user's task-related objectives and behavioral goals (usability). Hedonic attribute (also known as hedonic perception) refers to a product's ability to meet a user's non-task-related requirements (identification and stimulation). Similarly, Han et al. [9] also mentioned that product characteristics were identified and categorized into pragmatic and hedonic attributes.
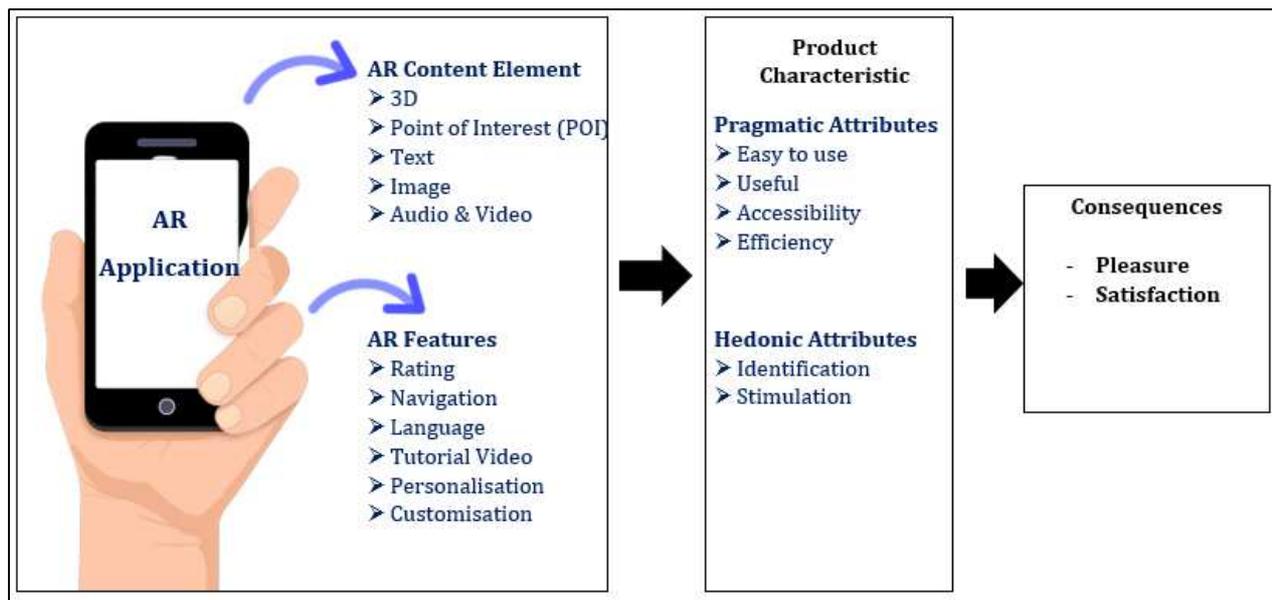

Fig. 5 User Experience Model of Augmented Reality Application for Historical Tourism

This study considers pragmatic features (manipulation) as to ease of use or usefulness and efficiency. On the other hand, cleverness, stimulation, evocation through knowledge in first-person perspective, convenience, and playfulness, particularly among youngsters, were identified as sub-factors for hedonic characteristics. In addition, Konstantakis and Caridakis [53] stated that both pragmatic (function and features) and hedonic (user expectation, motivation, and feelings) aspects play a role in the user experience. These characteristics may impact the user's good interaction with the system or product. As a result of the engagement with the application, the correlation of pragmatic and hedonic product characteristics builds the consequences as an emotional reaction.

When a product is utilized for tasks, pragmatic quality is essential and linked to usability and utility. As cited by Santoso et al. [54] and Wang et al. [55], the dimensions of effectiveness, comprehensibility, and reliability reflect pragmatic aspects of the item that are relevant to attaining the aim and the product's practical worth [56]. Furthermore, Hassenzahl [57] defined pragmatics as the product's perceived capability to assist the achievement of do-goals, which is the same as usability and usefulness [39]. Pragmatic is the task-related quality that consists of perspicuity, efficiency, and dependability [58]. Thus, pragmatic relates to practicality and functionality as the purpose should be clear, and the user should understand how to use it.

Sub–factors of pragmatic attributes were identified as easy to use, useful and accessible. An exciting feature concerning the utilization of AR technology is that both persons who had never used it before and those who had used it previously thought it was easy to use [59]. In a similar study, Adnan et al. stated that the AR applications are user-friendly, with easy-to-use navigation and customization [60]. The augmented

reality application is an easy-to-use, reliable, and effective navigation tool [61].

The use of augmented reality (AR) technology in heritage preservation activities proves useful. When users use it, a set of pop-up information cards appear on their smartphones' screens, particularly useful in the tourism industry to improve tourists' travel experiences. In the case of AR cultural heritage, multimedia content overlayed directly over architectural work is able to ensures that anyone watching will get a complete visual representation of what a location was like in the past. In reality, video mapping has been a popular technique for so-called "virtual restoration" in recent years: this method is not invasive to buildings because it does not physically alter their surface [62]. Likewise, Siang et al. [1] explained that AR is thought to be a useful digital technology for improving the tourism experience and paving the way for smart tourism because it can provide useful information, navigation, guides, and translations to tourists. Over the last decade, AR has been implemented into the Cultural Heritage market, mainly as a useful technology for supporting tourists within museums or heritage sites, and helps tourists experience and appreciate the artifacts on display by overcoming barriers of time, space, and language [43]. Thus, AR is considered a useful application for tourists.

AR applications should be accessible and can aid people in gathering information with real-time performance and precise timestamps. Obeidy et al. [63] stated that, as cited by Garau [22], for non-expert visitors, AR makes cultural heritage knowledge understandable and accessible. Other than that, the mobile AR application was accessible as it allows the model to be registered in various locations [43]. AR technology also allows for user-centered display and digital access to cultural material, especially when physical access is limited [64]. Therefore, AR application is accessible as it can be accessed anywhere.

On the other hand, hedonic quality is related to the user's sense of self, such as autonomy, competence, peer acceptance, or security. Hassan and Galal-Edeen [39] stated that hedonics is defined as the product's perceived ability to promote the fulfillment of one's goals. According to Lee et al. [58], hedonic describes non-task-related quality aspects: stimulation and originality. Hedonic features are assigned to dimensions of stimulation and innovation, which are not related to achieving the purpose but reflect the pleasure brought [56]. Thus, hedonic is related to the user expectation, motivation, and feelings. Hedonic attributes refer to the psychological needs and emotional experience of the user.

Using a product with a specific feature in a particular context will result in certain consequences, such as the experience of emotions (e.g., satisfaction or pleasure), the formation of detailed evaluations (e.g., appeal, attractiveness, and goodness assessments), or the creation of social behavior (e.g., approach, or avoidance). Hassan and Galal-Edeen [39] stated that the result of this process is the product's impact on the user, whether it's a behavioral effect (whether the user decides to keep using the product), an emotional impact (pleasure or satisfaction), or a judgmental influence (whether the product is good or bad). Likewise, Han et al. [9] explained that the relationship between pragmatic and hedonic product qualities builds the consequences as an emotional reaction due to the engagement with the application. UX should be evaluated after interacting with an object before and throughout that engagement [53]. Hence, UX is the consequence of these attributes plus the situation in which the product is used.

IV. Conclusion

MAR has modernized the way people interact and perceive digital information. The MAR system enables the user to successfully and efficiently engage with augmented information; however, understanding how users interact with this information to create a favorable UX is still required [11]. The aim of this study is to propose a UX model that can be used to give end-users an engaging and seamless MAR experience. Previous studies in the field of augmented reality in terms of historical heritage tourism have mostly focused on user acceptance and examining the factors that influence a visitor's decision to accept or reject the technology as part of a museum or historical site visit [27], [33]. The current study focused on the user experience of various application functionalities and application characters, and it identified various factors that influence users' satisfaction. Future adoption studies could implement the user experience proposed model, while user adoption and acceptance are significant areas of research for cultural heritage organizations to assess if such technologies are accepted or rejected.

The findings are significant for mobile AR application developers in historical tourism. The findings of this study present a user experience model of a historical tour guide for mobile AR application developers. Based on the user experience model presented in the study, developers are given a set of characteristics to affect tourists' experiences by strategically developing product features for mobile AR applications in the historical context. Additionally, the gap between product features and consumer expectations can be reduced in order to avoid user unhappiness and unfavorable user experiences. For future studies, this design guideline can be evaluated to ensure that it can be used by specialists in mobile AR, particularly in the tourism industry.

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