*Original Article*

# Fourth Industrial Revolution Review: Usage of Augmented Reality in the Malaysian Tourism Sector

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*Abstract - The tourism sector is one of the most important sectors of Malaysia. The Fourth Industrial Revolution technologies should be utilised to advance the tourism sector. This has been proven viable by many researchers globally. However, there is currently a lack of information on the utilisation of the Fourth Industrial Revolution technologies in the Malaysian tourism industry. Crimes such as pickpocketing are also a common occurrence in Kuala Lumpur; hence a way of alerting the tourists of crime hotspots is important, as such events will negatively impact their experience visiting Malaysia. The three main issues that will be focused on in this research are improving the walking navigation of tourists visiting Kuala Lumpur, improving overall tourist safety, and improving the current marketing methods of DBKL (Kuala Lumpur City Hall). This research aims to study the feasibility of integrating the Fourth Industrial Revolution technologies into the Malaysian tourism industry to solve the issues mentioned.*

*Keywords - Augmented Reality, Fourth Industrial Revolution, Malaysian tourism, Mobile application, Tourism industry.*

## 1. Introduction

The Fourth Industrial Revolution (FIR) is an overarching industrial transformation that covers every aspect of industries and economic activities, including every aspect of living [1]. Examples of countries that have integrated the Fourth Industrial Revolution well into their economies are Germany, China, and Singapore. In Malaysia, the major sectors that significantly contribute to the economy are manufacturing, agriculture, and services [5]. As of 2019, the Malaysian government is still working on the vision of the Fourth Industrial Revolution national policy. Malaysia's current manufacturing sector ranges from Industry 2.0 to Industry 3.0 [1]. Tourism is one of the most important sectors in Malaysia, contributing 14.9 percent towards Malaysia's overall economic growth. Hence, due to the significance of the tourism industry in Malaysia, it is only natural to adhere to the Fourth Industrial Revolution to move forward. The Fourth Industrial Revolution technologies will benefit both the tourists and the government. One of the core technologies in the Fourth Industrial Revolution is Augmented Reality (AR). AR is implemented in various sectors, such as the manufacturing sector.

In the manufacturing sector, workers are given training utilising AR via a handheld device, hence reducing the need for a trainer. In the tourism industry, AR can be useful for navigation, as AR allows for overlaying virtual elements on top of the physical space. Research has shown that AR navigation utilising smartphones yields better navigation results compared to Google Maps and conventional maps. Besides navigation, AR can also better convey information to tourists. Information that would be useful to tourists includes nearby interesting locations, events or even safety information. This paper will discuss implementing the Fourth Industrial Revolution technology, AR, via a mobile application within the Malaysian tourism industry. In addition, several use cases of AR in the tourism industry will also be reviewed. The paper is divided into a total of 7 sections: the introduction, current issues in the Malaysian tourism industry, relevant works to AR and FIR, proposed research methodology used, the proposed solution and concluding remarks for the paper.

### 1.1. Fourth Industrial Revolution

On a global scale, tourism is the main source of income for different countries, which enhances the economy of both guests and host countries. In the last decade, the number of both international arrival and departures has increased from 675,277,000 to 1,004,681,000 and from 590,511,000 to 858,913,000, respectively. In 2008, the tourism sector contributed 9.9% of the world's gross domestic product and was expected to increase to 10.5% by the completion of 2018 [6].

For example, in Japan, the number of tourists has increased since 2018. According to the Japan National Tourism Organization, compared to the month of January 2018, the number of tourist arrivals increased by 7.5 percent in January 2019. Japan has also revised their tourist arrival goal from 20 million to 30 million due to the upcoming 2020 Tokyo Olympic games [7]—another example of a country with increased tourism activity in Singapore. During the first quarter of 2017, Singapore experienced a 4 percent increase in international tourists arrival, reaching 4.3 million in number. While visiting Singapore, tourists have also spent 6.4 billion Singaporean dollars in tourism receipts, contributing to Singapore's economy [8].

In Malaysia, tourism is one of the most important sectors. In 2017, 25.95 million tourists visited Malaysia and spent 82.1 billion Ringgit during their visit. The number of tourists and the amount they have spent has been increasing each year since 2007 ("Malaysia Tourism Statistics in Brief"). The tourism industry contributed significantly to Malaysia's economic growth, with a share of 14.9 per cent in 2017. This information reveals the importance of the tourism sector to Malaysia's overall economic growth. Hence, due to the significance of the tourism industry in Malaysia, it is only natural to adhere to the Fourth Industrial Revolution to move forward. Like all sectors that undergo the Fourth Industrial Revolution, Malaysian Tourism will benefit greatly from technologies such as Cyber-Physical Systems and embedded technologies. These technological advances will benefit both tourists and the government.

The government has taken up several initiatives to transform the tourism sector in Malaysia to adhere to the Fourth Industrial Revolution. One of the initiatives is called Smart Tourism 4.0, which is a tie-up between Malaysian tourism and Tencent [9]. Tencent defined smart tourism as using advanced technologies such as Big Data and the Internet of Things to improve the tourist's experience. Both Big Data and the Internet of Things are two of the Fourth Industrial Revolution's core principles. Examples of Tencent's products that will be at the forefront of this endeavor are the mobile application WeChat, which will handle communication coupled with hassle-free payment functions and QQ, Tencent's very own digital platform to book accommodations and make travel plans [10].

### 1.2. Augmented Reality in Tourism
The Fourth Industrial Revolution technology of focus in this paper is Augmented Reality (AR). One prominent feature of AR is allowing for the ability to overlay virtual elements on top of the physical plane. This can be achieved by utilising any form of a mediator, such as a mobile cyber-physical system or smartphone. Hence, AR allows for additional information to be added on-screen virtually. Figure 1 shows the utilisation of AR on the smartphone, where the smartphone's camera is used to obtain the physical plane, and virtual objects are overlaid on top [11].

One of Augmented reality's (AR) main uses is for navigation. This could be attributed to the fact that AR allows for overlaying of virtual elements on top of the physical space. Research has shown that AR navigation utilising smartphones yields better navigation results compared to Google Maps and a conventional map. Additional information can be added to the smartphone's screen aiding tourist navigation. For this reason, it is significantly more useful compared to using standard navigation mobile applications or maps.

Types of navigation information include distance, direction, and location details [12]. Besides navigation, AR can also better convey information to tourists. Information that would be useful to tourists includes nearby interesting locations, events, or even safety information.



**Fig. 1 Utilisation of Augmented Reality on the smartphone [11]**

This additional information viewed through their smartphones will be able to enhance the travelling experience through suggestions of events that are occurring or will take place.

The potential of Augmented Reality (AR) in the tourism industry is immense, as can be seen in existing research papers such as ToARist: An Augmented Reality Tourism App created through User-Centered Design by Williams, Yao and Nurse [11], Augmented reality mobile tourism application by Pereira, Abreu and Pinho [13], Push typed tourist information system based on the beacon and augmented reality technologies by Sato, Hirakawa and Shibata [14] and Mobile tourism application using augmented reality by Safitri et al. [15]. Implementing one of the nine pillars of the Fourth Industrial Revolution allows the tourism sector to benefit from it and further allows the country and the tourists visiting to reap the benefits.

## 2. Issues in Malaysian Tourism
Three main problems with the current Malaysian tourism industry status will be discussed in this paper. The first is the lack of proper navigation tools for walking tourists, which could hamper their travelling experience in Malaysia in general and Kuala Lumpur specifically. Secondly, the current marketing methods of DBKL are still lacking and can be improved upon to allow for more effective marketing, thus, attracting more tourists to visit Kuala Lumpur. Finally, disaster information is one aspect Malaysia still lacks in notifying the tourists since tourists' safety is of utmost priority in any host country.

### 2.1. Navigation Issue
The mode of navigation for most tourists varies between different countries and cities. Different modes of navigation for tourists include public transport such as trains, buses, taxis, or even walking. Walking is a common option among tourists due to the chance of being able to interact with the environment [16]. However, current navigation features via mobile applications have certain disadvantages for tourists. Google Maps has a 2D bird's eye view, which can be troublesome to view the actual view on the street level. The user must be able to map the virtual bird's eye view to the actual view, which can sometimes be troubling [12]. This is especially true for places that the tourists are unfamiliar with, which is often the case. Google's Street View, on the other

hand, has limited access to certain private areas, such as museums and narrow streets in residential areas [17]. This limits the tourist's navigation to certain areas such as cultural events, areas and even museums.

For example, in Japan, the Yasaka shrine in Kyoto is a popular sightseeing spot, and tourists usually visit the area on walking. There are also many narrow streets in the area, and tourists would easily get lost even though many guideboards are scattered throughout. Currently, several personal navigation systems are available such as P-Tour and Raku-Raku. However, these systems are only suitable and accurate for cars instead of on-foot travelling [16].

In Yogyakarta, Indonesia, most tourist attractions situated in the city center are within walking distance; tourists can experience urban street tourism only by walking. Many tourists walk in the streets, hence being a street guide is a main source of income. However, if the tourists wish to navigate Yogyakarta streets by themselves, this proves to be difficult, as the city has an incredibly dense population [18]. Another example is in Kuala Lumpur, Malaysia, where the main mode of navigation for tourists in the area is by walking [19]. Some of these private areas are sometimes part of the tourism experience where. The lack of proper navigation in those areas limits the overall tourist experience in Kuala Lumpur.

### 2.2. Marketing Strategy

Tourism marketing is an important factor in deciding the success of a country's tourism industry. Globally, there are various mediums that can be utilised for the purposes of tourism marketing. For example, in the United Kingdom, some of the main marketing strategies employed are through word of mouth, websites, social media, brochures and more [20]. Japan's tourism marketing strategy includes improving the English-speaking sectors, stepping up marketing on English-based social media such as Facebook, Instagram, and Twitter, and utilising airline marketing [21]. In Singapore, the tourism board realises that traditional marketing methods such as billboards, flyers and newspaper print ads are slowly becoming ineffective. Hence, the focus will be shifted to digital marketing as internet, and smartphone-savvy users increase [8]. These examples show the importance of digital marketing, which includes mediums such as social media and websites. However, tourism marketing in Kuala Lumpur, Malaysia, is lacking in digital marketing and is more focused on conventional media such as the television [22]

In Kuala Lumpur, the current marketing strategies include airline marketing, advertisements in media, etc. [22]. These are conventional methods of marketing. When referring to advertisements on media, these include television, streaming websites, and such. However, while traveling around, it is unlikely that tourists would have time to watch television or access streaming websites. Even if tourists can access and view tourism advertisements, they will be delayed and not up to date. Marketing of events is also usually limited to banners and flyers; though this is still viable, it should be complemented with electronic advertising to allow for more effective marketing [47]. This would also involve the additional task of cleaning up once the banners and flyers are

past the event's date. Moving towards the Fourth Industrial Revolution, marketing methods should not be limited to only traditional media such as television or radio.

**Table 1. Three highest states in Malaysia with the number of violent crime cases respectively (Anuar, N. B., & Yap, B. W., 2019)**

| State | Number of Violent Crime Cases |
|---|---|
| Selangor | 91,962 |
| Kuala Lumpur | 59,050 |
| Johor | 49,105 |

### 2.3. Navigation Issue

Tourism is considered a fragile industry as there are many discouraging factors involved. For example, a lack of safety assurance or a widespread crime is discouraging. Safety is a critical issue in the tourism industry in many countries, including Malaysia. The absence of crime is essential for tourism as crimes occurring in tourism are usually highly publicised, especially through international news outlets. This will cause doubt and fear among tourists regarding safety when visiting a country (C.-H. Tan et al., 2017). In 2014, Kuala Lumpur was voted as the second-ranked state in Malaysia with violent crime cases occurrences after Selangor. Incidentally, Kuala Lumpur is also one of the most visited cities in Malaysia by tourists. Hence tourist safety should be the highest priority (Anuar, N. B., & Yap, B. W., 2019).

In the United States, there is a mobile application called Smart Traveler that allows its users to view important travel alerts of destination countries. Once users are signed up for the Smart Traveler Enrollment Program (STEP), they can utilise the Smart Traveler mobile app to obtain travel alerts and warnings of any destination country (U.S. Department of State, 2019).

Japan has always been known for having a low crime rate, but it is constantly prone to natural disasters. Therefore, tourism safety in Japan also involves warning tourists of impending earthquakes and tsunami situations. A mobile application developed by the Japan Tourism Agency called Safety Tips is an application that has functionalities such as evacuation flowcharts, communication cards with handy phrases, and helpful disaster-related information. Research in Japan suggests the usage of Augmented Reality (AR) in smartphones to convey disaster information to international tourists to create awareness and educate (Sato, 2017). This is done by conveying disaster information to the tourists when they reach a particular point of interest. When the smartphone is held up, the mobile application will utilise the camera and AR to overlay the disaster information and photos to educate the tourists regarding disasters that have occurred previously in the area on the smartphone's display.

In Malaysia, Tourism Malaysia launched a mobile app called 'My Tourist Assist' (MyTA). MyTA aims to ensure safe travel for tourists in Malaysia. Features of MyTA include an emergency or SOS button that will connect the user directly to the authorities. Tourists will also be able to view the latest

news sourced from Bernama through the mobile app. Additional functionality includes displaying the location of essential services such as hospitals, pharmacies, police, automated teller machines (ATM) and embassy locations. In addition, the Royal Police Force has several mobile apps that allow its users to make police reports anytime without the hassle of going to the police station. However, these mobile apps are aimed at locals (Kugan 2018).

## 3. Related Works

The Fourth Industrial Revolution's involvement in the tourism industry has been steadily increasing over the years due to the technological advancement in Information Communication Technology (ICT) and the highly lucrative tourism industry. According to Yoon [28], the Fourth Industrial Revolution has three focuses in the tourism industry, and these are trends for the future of tourism. These key focuses are personalising the tourist experience, introducing various new tourism experiences and efficiency in operating the tourism industry.

Augmented Reality (AR) is one of the nine core technologies of the Fourth Industrial Revolution, which is the focus of this research. The main aim of AR is to provide a way to access and manipulate information, enhancing the perception of the real world with virtual information layered on top [29]. According to [30], AR is also defined as integrating computer-generated visual information onto the real-world environment. The computer-generated visual information can include images, videos, 3D model texts, and sound and speech instructions [29]. Azume et al. [31] specified that AR has three key properties, which are presenting virtual and real objects together in the environment, allowing interaction of real and virtual objects in real-time, and aligning virtual objects with real objects.

As previously mentioned, two of the most important and earliest application areas for AR in tourism are navigation and wayfinding, where most Mobile Augmented Reality (MAR) apps are being developed; these MAR apps have the purpose of being implemented in prototypes and commercial tourism-related applications. The reason navigation MAR apps are popular is that augmented display has the potential to reduce the mental effort required. This is especially useful for tourists who wish to explore a city they are visiting via visual, audio and 3D location-based information [32].

Examples of such MAR navigation apps include Google Maps AR navigation: an upcoming MAR navigation app by Google which is current as of 2019 is in the beta testing phase [33], and Sygic Navigation app: the navigation app by Sygic incorporated with AR, allowing for improved navigation experience on the road [34], AR City: an AR navigation app by a company called Blippar that aims to allow its users to navigate and explore 300 cities around the world [35] and GeoTravel Guide: a mobile tourism guide that allows tourists to view details regarding a point of interest via AR and navigating to a location, in addition to that, information regarding the point of interest sourced from Wikipedia can also be downloaded [13].



**Fig. 2 The User Interface of the CorfuAR mobile application displaying several points of interest based on the tourist's preferences. [32]**

### 3.1. CorfuAR Augmented Reality Tour Guide

Several research has been conducted to test the viability of MAR apps for tourists; an example of this research is "Tourist's responses to mobile augmented reality travel guides: The role of emotions on adoption behavior" by Kourouthanassis et al. [32], where a MAR app called CorfuAR, which is a fully functional prototype of a mobile augmented reality tour guide is tested by tourists on the island of Corfu in Greece. Figure 3.1.1 shows the user interface of the CorfuAR mobile application.

CorfuAR aims to guide tourists by displaying information on all the points of interest (POI) on the island in AR; selecting a POI will provide navigation information to that specific POI. Furthermore, CorfuAR also has embedded personalisation features, where the app will recommend POIs to tourists based on their previously visited POIs. CorfuAR also has a social media feature where tourists can rate, give, and view the feedback of a POI. Overall, the tourists were satisfied with CorfuAR in terms of both an emotional and usability standpoint.

### 3.2. Explorasia Mobile Tourism Application Using AR

Another research paper that assessed the viability of MAR apps in the tourism industry is titled "Mobile Tourism Application Using Augmented Reality" by Safitri et al. (2017), an Android-based MAR app that aims to improve the tourism industry in Indonesia called Explorasia was developed. Explorasia identifies an image target and generates an AR element related to it on top of the image. Explorasia allows users to scale and interact with the generated AR element; tourists will also be able to view additional information displayed on the smartphone screen, as shown in Figure 3.2.1. Based on the results obtained by allowing Explorasia to be tested by 50 respondents, 80 percent of them strongly agree that the app will be able to help to promote Indonesia's tourism industry.

## 4. Research Methodology

Based on Figure 2, the research methodology used in this research is applied in 3 different phases. Both phases 1 and 2,

the phases are further divided into 2 more phases, respectively, while phase 3 is a singular phase. The first phase will identify the current utilisation of the Fourth Industrial Revolution technologies in the Malaysian tourism industry. For this purpose, a literature review is used to identify the body of knowledge relevant to this research. Documents such as research papers, journals, newspaper articles, the government's tourism sector website, etc., will be used as references. The result obtained from this phase will determine the current progress of utilising the Fourth Industrial Revolution technologies in the global and Malaysian tourism industries. The result also includes the Malaysian government's initiatives for the tourism industry in the context of the Fourth Industrial Revolution, the Fourth Industrial Technology that is currently or will be implemented in Malaysian tourism, and the impact of the current implementation of the Fourth Industrial Revolution technology in the Malaysian tourism sector. These results from phase one were then used to aid the data collection process in phase two.
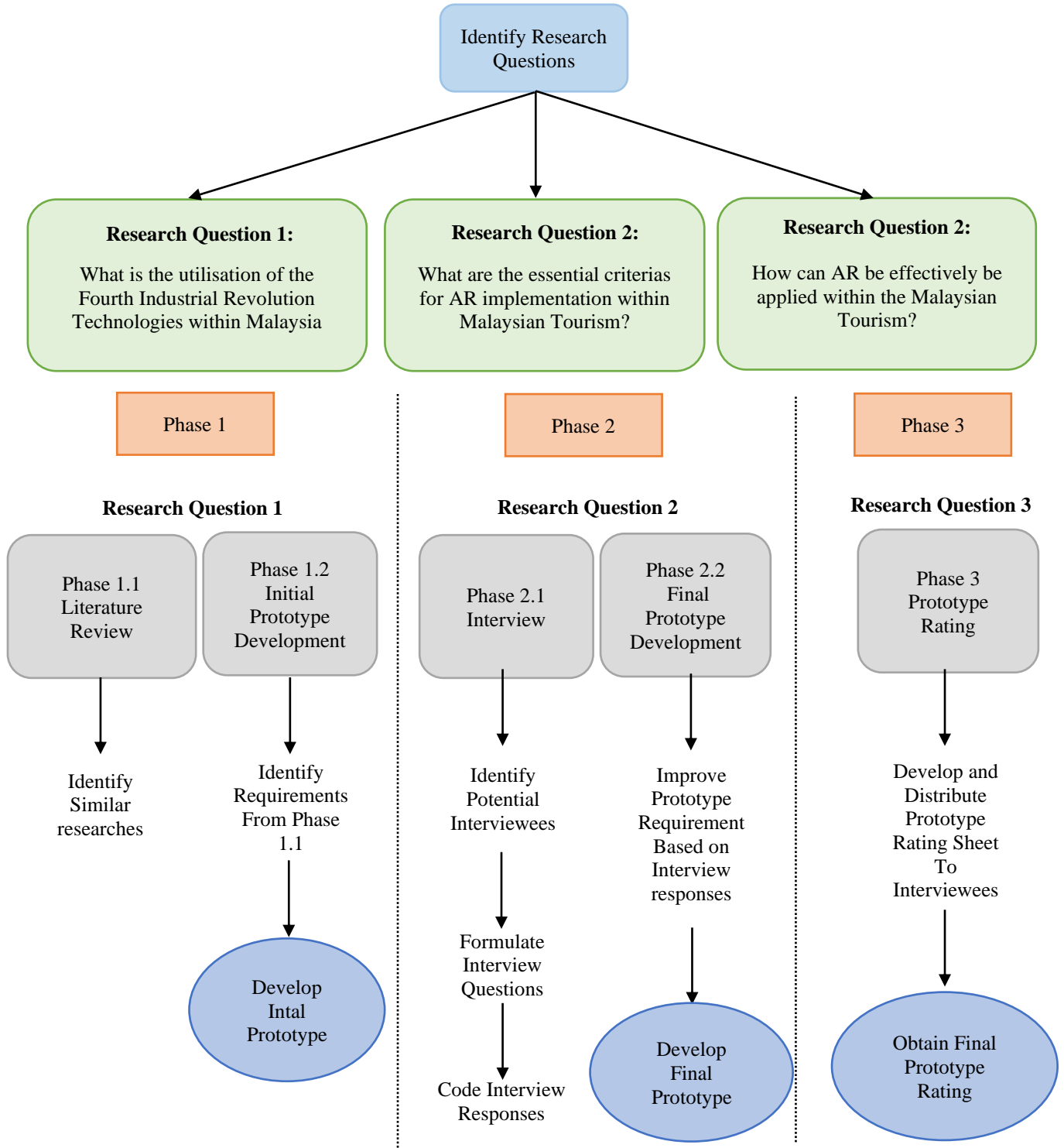


**Fig. 3 The three phases of the research methodologies applied in this research.**

Based on the information obtained from the literature review in the first phase, further data collection was conducted in phase two. For phase two, the research identifies the essential criteria for Augmented Reality (AR) implementation in Malaysian tourism. Hence the suitable research method interviews. The interviews allow the researchers to obtain detailed qualitative data on understanding the interviewee's experience, the way the experience is described, and the meaning behind those experiences [13]. This is because it is vital to obtain information regarding implementing new technologies, and this information can be obtained by interviewing government staff or officials that have experience working in the tourism sector. They are much more familiar with the environment and policies of the Malaysian tourism industry; hence, their answers are useful in determining the essential criteria of applying any technologies, which in the context of this research is one of the Fourth Industrial Revolution core technologies, which is AR.

Besides the experts, a total of 20 interviewees were interviewed. The interviewees in this research were both foreign and local expatriates working at private-sector companies. Although tourists are considered for this research, it would be an inconvenience to them as it requires them to return for phase 2 of the research [11]. The interviewees are then grouped into 3 possible residency statuses used in this research local, out-of-state, local and foreign. Locals' interviewees are interviewees that reside in Kuala Lumpur and are familiar with the area.

**Table 2. shows the different interviewee type and their respective numbers and description.**

| Interviewee Type | Number of Interviewees | Description |
|---|---|---|
| Local | 5 | Currently resides in Kuala Lumpur |
| Out of State Local | 5 | Currently resides outside of Kuala Lumpur but visits Kuala Lumpur frequently. |
| Foreigner | 10 | Currently resides in Malaysia, unfamiliar with Kuala Lumpur |

Local Out of State interviewees reside in areas outside Kuala Lumpur and occasionally visit Kuala Lumpur. Finally, the final interviewees are foreigners that are unfamiliar with Kuala Lumpur. The possible type of interviewees is shown in the table above.

Both prototyping and literature review research methods are utilised for the third phase of the research methodology. A prototype was developed based on the results of the previous two phases: the literature review and the interview. A prototype is important as it allows the target users, which in this case are the tourists, to have a firsthand experience in both the design process and decisions of implementing features [36].

In addition to that, the literature review is important for this phase as there are several research that discusses a similar topic as this research. Hence, information regarding previous research can be obtained to improve upon the current work and to identify the progress of the current trend of the Fourth Industrial Revolution.

## 5. Data Collection Method

Three research methods will be utilised for this research, which are literature review, interview, and prototyping. The utilisation of each research method is arranged into 3 phases, as explained in the previous section.

### 5.1. Interview

The interview sessions allowed the collection of detailed information from an expert's point of view. A set of interview questions can be prepared beforehand for this purpose for a structured interview. Questions may include whether the research in question is suitable to be implemented within government agencies. A semi-structured interview would also be useful, as it allows for open-ended questions and discussions with the interviewee. It is also important that the interview questions align with the research questions; for this purpose, an interview protocol matrix can be constructed.

Table 3 shows an example of an interview protocol matrix [37]. The table is constructed in a way where the leftmost column is the interview questions, and the topmost rows are the research questions, the cell where both the research question and the aim of the interview questions coincide, and the cell is crossed out.

**Table 3. Interview matrix protocol (Adapted from Castillo-Montoya [37])**

| | Research Question 1 | Research Question 2 | Research Question 3 |
|---|---|---|---|
| Interview Q1 | x | | x |
| Interview Q2 | x | x | |
| Interview Q3 | | x | |
| Interview Q4 | | | x |

During and after the interview, several additional steps and care are to be taken to ease information retrieval on the interview responses post-interview. These steps include [38]:

1. To take minimal notes during the interview. These notes can be amplified after the interview session.
2. To make sure verbatim notes are taken during the interview so that the point of the interviewee's original response is retained.
3. Audio recording is useful for recording the interview process and is to be stored as a reference.
4. Make additional notes from memory after the interview.

Interview questions are adapted from previous research with similar aims to this study. The sampling technique used to choose the suitable interviewees for this research is purposive sampling. According to Luborsky and Rubenstein

[39], purposive sampling involves selecting interviewees or subjects based on predefined traits or conditions. Hence, the potential interviewees suitable for this research are the government staff working under the Culture, Arts, Tourism and Sports department of DBKL. They will be able to provide valuable insights into the government tourism sector's operation, allowing for a better understanding of the research at hand.

With the knowledge and experiences, they have, the proper understanding of the implementation of Augmented reality in the government tourism sector can be obtained through the interview process. The maximum number of potential interviewees is 21 people as these are the number of available staff that work in the Culture, Arts, Tourism and Sports department [22].

### 5.2. Themes and Subthemes

By analysing all the participant's responses, a total of 5 main themes and 9 subthemes were obtained. Themes are used for different group subthemes, while subthemes are used to code and group the participant's responses with similar themes; for example, if the main theme is Functionality Feature Improvement, the related subthemes would be Navigation, Marketing and Crime Hotspot feature improvement. Themes are derived from mobile application aspects such as user interface and features, while subthemes are derived from My-ARt's main functionalities. Table 4 shows all the themes, its description, and related subthemes.

**Table 4. Interview matrix protocol (Adapted from Castillo-Montoya [37])**

| Themes | Descriptions | Subthemes |
|---|---|---|
| Functionality Feature Improvement | Theme to group responses that suggest improvements in My-ARt's functionalities encompassing AR navigation, marketing, and Crime Hotspot. | 1. My-ARt's AR Navigation Feature Improvements 2. My-ARt's AR Marketing & Events Feature Improvement 3. My-ARt's Crime Hotspot Feature Improvements |
| Importance of Feedback or Communication | Responses that emphasise the importance of feedback functionality within My-ARt | |

### 5.3. Prototyping

A prototype Augmented Reality (AR) mobile application was developed as a proof of concept. This approach allows for a hands-on evaluation of whether Augmented reality would be viable for the research purpose. A prototype is important as it allows the target users, which in this case are the tourists, to have a firsthand experience in both the design process and decisions of the prototype's feature implementation [36]. Once proper feedback is obtained, the prototype can be further improved to better serve its purpose. The number of participating users is 20 people, as suggested by Williams, Yao, and Nurse [11]; instead of inconveniencing tourists, a good alternative would be overseas university students or students from another state as they are not acquainted with the local environment.

The data from the prototyping will be used to answer the third research question, which is how Augmented Reality can be applied effectively within Malaysian tourism. Feedback can be obtained from the participating users regarding the viability of implementing the said prototype. For the prototype to be successful, an optimum result would be 80 percent of the participating users giving positive feedback [40]. The rating system for the prototype is explained in the next section. The prototype rating system consists of 3 columns, which are the prototypes feature, the ratings, and remarks given by test users. The first column lists all the features of the prototype that is to be tested by the test users. The features will include criteria such as the functionalities of the prototype, the user-friendliness of the prototype's interface and general usefulness. The second column allows the test users to rate a particular feature from 1 to 5, where 1 is the minimum score, and 5 is the maximum rating. The final column is where test users can justify the rating given to a particular feature; this column can also be used for test users to suggest improvements for the prototype.

## 6. Result

As discussed in section 4, the research methodology begins by developing an initial prototype, which is then improved via interview results and data analysis. Once the final prototype is developed, interviewees would then rate the prototype for a final rating. This section shows the results from each of the phases.
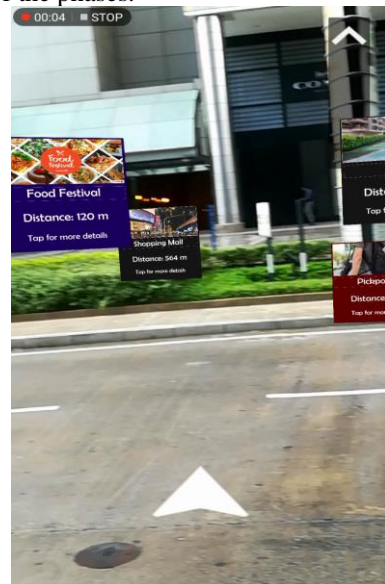


**Fig. 4 shows My-ARt's initial prototype main UI**

### 6.1. Initial Prototype

The prototype's name was given My-ARt, which stands for Malaysian Augmented Reality Tourism. My-ARt has three main functionalities, as previously discussed:

1. To display tourists' places of interest in AR, including navigation support.
2. To display nearby marketing and events for tourists in AR to promote tourism.
3. To display nearby crime hotspots in AR for tourists' safety in alerting and avoiding dangerous areas.

My-ARt's main UI consists of three colour-coded AR elements of Tourist Places of Interest, Interesting Events and Crime Hotspots, represented by black, dark blue and red, respectively. Tourists are presented with additional information regarding a particular location upon interacting with the AR element. Additional information includes opening hours, location description and full address. Opening hours are only available for places of interest and events. On the other hand, crime hotspots display types of crimes that occurred or security precautions.

### 6.2. Interview Results and Analysis

The next section highlights the result and analysis that is based on the data collected from the interviewees. Their feedback is recorded and categorised into 3 main areas: UI improvements, marketing/events improvements, and crime hotspot improvements.

### 6.2.1. My-ARt's User Interface (UI) Improvement Suggestion
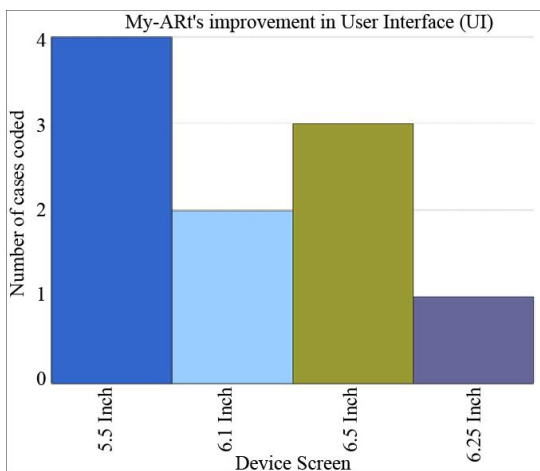


**Fig. 5 Interviewees with different device screen sizes suggesting improvements to My-ARt's UI**
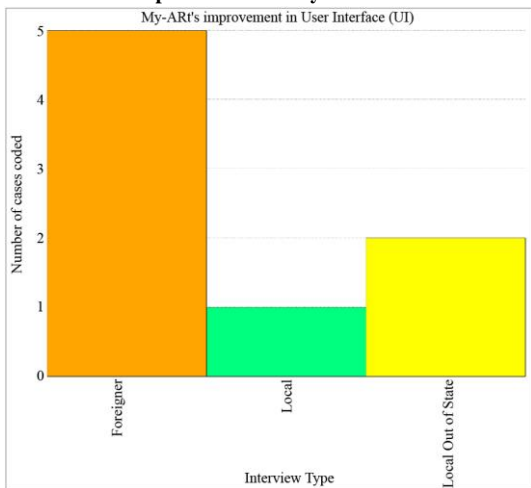


**Fig. 6 The different interviewee types and their feedback regarding marketing improvements.**

Based on figure 4, 45 percent of the interviewees responded with suggestions and feedback regarding My-ARt's user interface, with the remaining interviewee expressing satisfaction. As shown in the graph, the smaller the device screen size, the more concerned the interviewee is about the UI aspect of My-ARt. Their primary concern is related to the size and visibility of the AR element and font sizes of texts within said UI, especially among interviewees with smaller device screens.

For the improvement of My-ARt's UI based on the interviewee responses, two improvements can be implemented. The first one is adaptive text size, meaning text size will be scaled according to the device screen size. This allows texts to be displayed more clearly for users with smaller device screen sizes, especially 5.5 inches and below. The second UI improvement is showing additional menu options only when required, reducing unneeded clutter on the screen. Hence, My-ARt's menu option becomes transient, hiding outside of the viewport unless the top part of the UI is tapped by the user [42]. When filters on the main screen are not used after 5 seconds, My-ARt will hide the filter menu until required, which the user will be accessed by touching the top part of the screen.

### 6.2.2. My-ARt's Marketing and Events Improvement Suggestion

Around 8 interviewees suggested that some improvements can be made to improve My-Art's marketing and event functionality. 50 percent of the total foreigner interviewees voiced their opinions, which is 5 interviewees, the highest among all the interviewee types. In comparison, only 1 out of 5 local interviewees and 2 out of 5 out-of-state local interviewees suggested improvements of any form towards My-ARt's marketing and event functionality, which is 25 and 40 percent, respectively.

P11, a foreign interviewee suggested that a list of offered items and discounts are presented within the marketing detail. This is to attract tourists to a certain mall or location while also providing the benefits of savings and discounts. P12, another foreign interviewee remarks that a marketing and event-specific filter should be added so that tourists can choose between events or discounts for items.
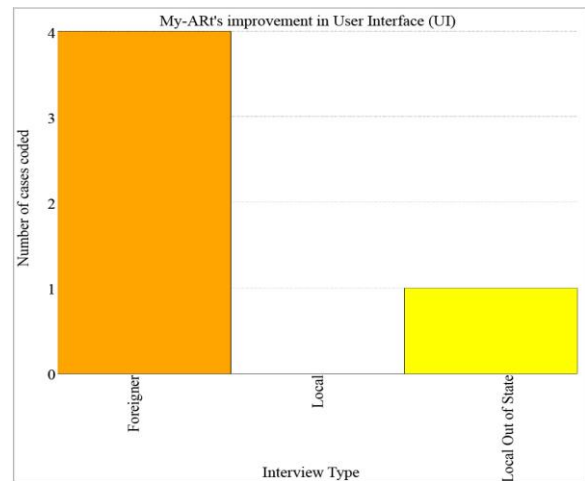


**Fig. 7 The number of each different interviewee group responding with improvements for My-ARt's crime hotspot functionality**
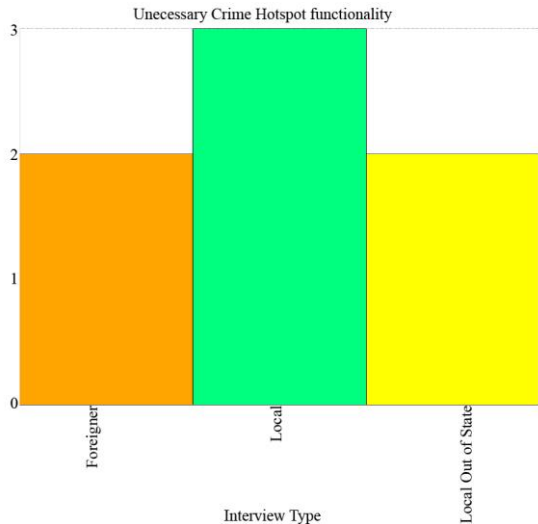
**Fig. 8 The number of each different interviewee group that feels My-ARt's crime hotspot functionality is unnecessary.**

Marketing and filters allow for a more personalised experience for tourists. Since the users manually set the filters, there is no risk of data collection and security concerns for the tourists. According to Strycharz et al., users feel that applications that collect personal data are "creepy" and most likely will sell the data to third parties [43]. Hence, in the final My-ARt prototype, the marketing and event filter is added to differentiate different types of events and marketing deals, while users still retain control of it without My-ARt collecting any personal data.

### 6.2.3. My-ARt's Crime Hotspot Improvement Suggestion
About 20 percent of the interviewees suggested improvements to My-ARt's crime hotspot functionality. Foreign and local out-of-state interviewee groups have improvement suggestions, while local interviewees have no suggestions towards crime hotspot functionality. Based on the graph shown below, most interviewees that deemed crime hotspot functionality unnecessary are local interviewees, which are 3 out 5 total local interviewees. Hence, the lack of interest in utilising the crime hotspot functionality, in turn, causes the local interviewees to have not much of suggestions.

The fact that foreign interviewees are more concerned about the crime hotspot aspect of My-ARt could be attributed to their unfamiliarity with Kuala Lumpur and their concern regarding tourists' security and safety. The responses from foreign interviewees are particularly important as tourism security concerns can be addressed by closing the gap between the expectations of tourists and reality regarding the security level of Kuala Lumpur, especially in public places [41].

Interviewee P13 suggested, "add in safety tips and things like that". P13 highlighted that additional functionality that can be added to My-ARt is to display a list of safety tips that can be useful for tourists. Another suggestion is by P17, "recent news related to a particular hotspot is displayed upon selection.". P17 suggested that a news section should be

added so tourists would be more aware of any incident that occurred in a crime hotspot shown by My-ARt.

Crime hotspot feedback is one of the important features that the interviewee requests. Hence, in My-ARt's final prototype, a feedback functionality is added to one of the most tourist feedback-dependent features of My-ARt, the crime hotspot. This will be discussed in the next section.

### 6.3. Final Prototype
After analysing the feedback from the interviewees, My-ARt's final prototype has improved its UI with an increased focus on the AR elements and simplicity. These improvements include increased text size for mobile devices with smaller screens, as shown in Figure 9. These were done to address a few interviewees' feedback regarding the UI; heavier emphasis is also placed on the AR elements to ensure it is clearly shown to the user. The final prototype also added feedback functionality for crime hotspot identifications allowing tourists to mark locations they deem unsafe; this was suggested by interviewees that felt that there should be a communication channel between the government's tourism sector and the tourists.
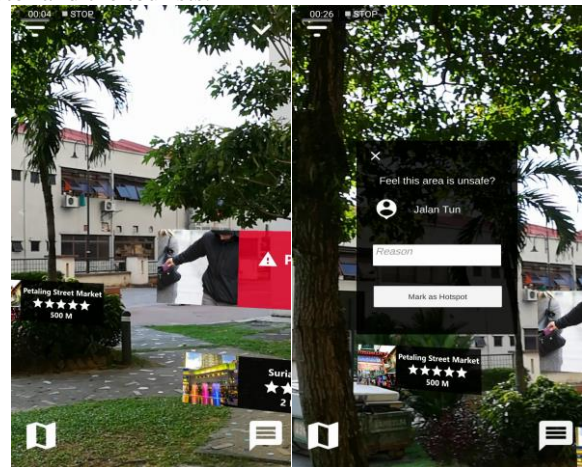


**Fig. 9 My-ARt's final prototype improved UI (left) and the new crime hotspot feedback feature (right).**
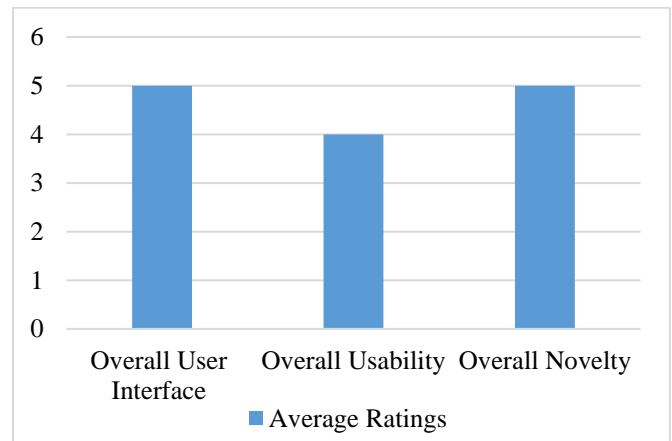


**Fig. 10 The prototype features and their respective ratings**

### 6.4. My-ARt's Final Prototype Rating
Once the final My-ARt prototype was developed, all 20 interviewees were invited to test the application. Once each of the interviewees explored the improved prototype version,

they were instructed to provide feedback. Refer to Figure 10 for the average rating obtained. The maximum rating that can be given for each feature is 5.

Upon reviewing My-ARt's final prototype rating, all interviewees agree that My-ARt's UI is simple and intuitive, with all the interviewees rating it at 5. The average rating of My-ARt's usability is 4 out of 5, as the AR aspect of the app requires the interviewees some time to get accustomed. The interviewees also agree that the proposed development of an AR-based tourist navigation, marketing and safety app is novel compared to similar navigational apps they have used, such as Google Maps and Waze. The outcome of this research is to offer effective integration of the Fourth Industrial Revolution within the Malaysian tourism industry via utilising a Mobile Augmented Reality (MAR) application. This allows for the growth and modernisation of the tourism industry within Malaysia [5]. Hence, allowing for better overall economic growth and a forward step toward applying the Fourth Industrial Revolution concept in other economic sectors in Malaysia. As discussed in sections 6.1 and 6.4, a prototype mobile application named My-ARt was developed with three main objectives: 1) to aid tourists in navigating the city of Kuala Lumpur through the usage of Augmented reality as a proof of concept, 2) tourist safety and, 3) to allow DBKL to utilise the mobile application for tourism marketing purposes

## 7. Conclusion

This paper highlights the importance of tourism in contributing to the Malaysian economy. The Malaysian tourism industry has been well received by tourists, as proven by the increasing number of tourists over the years. However, with the increasing prevalence of the Fourth Industrial Revolution in various economic sectors, the Malaysian tourism sectors should also implement these technologies to reap the benefits provided. Augmented Reality (AR) usage via mobile application is suggested in this research after considering multiple benefits for tourists and the Malaysian tourism sector in general. This sentiment was also proven by several similar research conducted in other countries, as

shown in section 3. The benefits include AR navigation for tourists and better marketing tools for DBKL.

By introducing the utilisation of the 4th IR technology, Malaysian tourism can be improved. Globally, several existing research demonstrates the viability of the 4th IR technologies in the tourism industry [15][32]. However, that is not the case for Malaysia. In Malaysia, Augmented Reality (AR) is not often bought up as the existing research is limited to case studies, software requirements, or the limited use of AR [40][45][46]. Tourism is one of Malaysia's main industries, with a significant contribution to the economy, as discussed in section 1. The My-ARt mobile application proposed in the research aims to introduce AR implementation into one of the many essential industries in Malaysia, specifically the tourism industry. There has been researching done on AR-based tourism apps. However, these are limited to displaying places of interest. From the research results, most participants have shown interest in utilising such a mobile application, as most of the results showed a positive outlook towards the My-Art application. The three main functions of My-ARt, which were proposed (places of interest, marketing/events, and safety), are not provided in other existing tourism applications in Malaysia.

As part of future work, further exploration of the requirements of tourists with the ongoing COVID-19 pandemic and how this affects the traveling pattern should be examined. Additionally, the My-ARt's functionalities and UI can also be improved further by only showing the necessary UI components when the user needs them and placing a greater emphasis on the AR elements. Lastly, My-ARt's places of interest filtering can also be improved by adding more options for the users instead of just location types and distance. Additional filters such as age, gender and more can be used to cater the application output to the users.

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