The Future Is Here

AUGMENTED REALITY In TOURISM

Queensland Government

UQ BUSINESS SCHOOL
THE UNIVERSITY OF QUEENSLAND AUSTRALIA

DENG Xingchen
DING Yihan
KHEDKAR Prerana
SHEN Yi
WANG Xiaojing
ZHANG Yue
ZHU Xijia

Executive Summary

This report provided an analysis and evaluation of Augmented Reality (AR). This project was undertaken for the Department of Innovation, Tourism Industry Development and Commonwealth Games (DITID). It would provide insights into the world of AR, its opportunities, challenges and applications in the Queensland's tourism industry as well as how the Queensland Government and the Queensland (QLD) tourism industry could help encourage the usage of AR. The main focus was to develop the onsite visitor experience through the use of mobile devices.

The report explained the definition, evolution and the applications of AR in various industries. It also elaborated on the current AR application in the tourism industry within and outside of QLD. For a clearer understanding, two case studies (Jinsha Site Museum and Ingress) were conducted which provided some insights for the QLD tourism industry. The report also discussed the supply side and current government support in AR adoption including the existing programs in QLD and other jurisdictions within Australia.

China is one of the top market for QLD tourism international market. As Chinese millennials are more familiar with AR technology, they were studied through a qualitative approach. Consultations with innovation team from the department and the industry, focus groups, WeChat interviews helped us gain some great insights. The findings were mainly developed from four dimensions, including individual experience of AR, QLD image, onsite experience and AR Applications (Apps).

Based on the research findings, several recommendations are put forward to both the government and the tourism operators. The government could increase the awareness of AR Apps by actively cooperating with the stakeholders and conducting focused marketing campaigns for the Chinese visitors. At the same time, providing technical support in terms of improving the reception could also help. Building platforms and provide training could help bring the technical specialists and industry leaders together. To tourism operators, they could consider go through the influential factors and make the App user-friendly which would encourage its use further. Safety issue could also be focused. The operators might also consider improving the content quality by conducting marketing research and designing the App according to different target markets' needs. Lastly, providing an all-in-one App would be appreciated by the Chinese visitors.

CONTENTS

BACKGROUND

Tagged as a renowned destination, Queensland (QLD) has a lot to offer ranging from cosmopolitan urban areas, delightful shorelines, to tough outback areas and benevolent nation towns.

Tourism is considered as one of the main industries in QLD work sector. According to Tourism and Event Queensland (2017a), It is a $25 billion industry accounting for 7.9% of its gross state product (GSP). In the year end December 2017, the state's residents welcomed 29.2 million overnight visitors (TEQ, 2017b).

Figure 1: Visitation-2017

● **International Visitors: 2.7 Million**

● **Domestic** (Overnight visitation)
Intrastate Visitors: 15.2 Million
Interstate Visitors: 6.6 Million

(Source: TEQ, 2017c; 2017d)

QLD tourism industry holds one of the leading positions in all Australian states, occupying 23% of Australia's total tourism expenditure (Tourism Research Australia, 2018).

One of the fastest growing inbound tourism market is China. Other Asian markets are India, Korea, Taiwan and Hong Kong (Business Queensland, n.d.).

Figure 2: Top 5 Markets by Expenditure-2017

1	China	$1,142M
2	New Zealand	$552M
3	Japan	$432M
4	UK	$417M
5	USA	$360M

(Source: TEQ, 2017c)

BACKGROUND

According to these facts, the Queensland Government is committed in supporting an innovative tourism sector. The Department of Innovation, Tourism Industry Development and the Commonwealth Games (DITID) provides leadership in Advance QLD initiative, making QLD an attractive destination for investment, tourist and events (DITID, n.d.). It cooperates with other government institutions and industries to develop strategies and capabilities to actualize the Queensland Government goals.

Augmented Reality / Virtual Reality (AR/VR) technology is the hottest topic for enterprises in recent years. Lately, companies like Microsoft, Apple, Samsung and HTC have unveiled more AR products to the mainstream (Yung & Khoo-Lattimore, 2017). With the rapid technological advancements, AR and VR have strongly impacted the way people experience their surroundings (Jung & tom Deick, 2017) and increased its availability in the tourism sector (Han, Jung & tom Deick, 2017).

Over the past few years, AR keeps developing and has been implemented across many industry sectors (Han, Jung & tom Deick, 2017). Education, retail, healthcare, entertainment and tourism are the industries which involve the use of AR application. For instance, in manufacturing and retail industry, AR technology in geolocation and personalization allows more precise and tailored marketing messages to the customers (Yung & Khoo-Lattimore, 2017).

BACKGROUND

From Jung and tom Deick (2017), AR improves tourists experience by generating positive learning attitude of the cultural heritage and enhances their satisfaction. However, some reports also pointed out some common barriers of AR in application, such as the ease-of-use for customers (Yung & Khoo-Lattimore, 2017; tom Dieck & Jung, 2018) and the high cost of applying for the tourism sites, which is a critical concern for small tourism organizations (Jung & tom Deick, 2017).

Though AR can be utilized to facilitate tourism experience, there is limited research of AR in tourism from the government side, especially in terms of the current situation of AR in the specific destination, the approach helping AR adoption to enhance tourist experiences onsite, and the way the government supporting AR adoption in QLD tourism industry. Thus, this research is conducted.

Purpose and Objective

To address the gap, this project is set out to provide information, insight and inspiration of AR technology application that DITID can promote to the QLD tourism industry, focusing on developing visitor on-site experience through mobile devices.

Specifically, this report aims to:

1) Identify the opportunities, challenges and applications for AR technology used for onsite experience on mobile devices in the QLD tourism industry.

2) Identify what role the QLD tourism industry and the Queensland Government can play in encouraging the uptake of AR technology in the mentioned field.

3) Provide recommendations on what and how the Queensland Government and the Queensland tourism industry could do to adopt the AR technology.

Existing Augmented Reality Research

Existing AR Research
Augmented Reality

Augmented Reality (AR) is about using layers of computer-generated images through a device to enhance a real-world environment (Guttentag, 2010).

It overlays the virtual objects onto the image of the real world to integrate augmentations with reality, so that the simulation of complex concept can be reached, and the users can immerse themselves to some extent in a blended physical environment (Xue, Bang & Sharma, 2017; McCall, Wetzel, Löschner & Braun, 2011).

Figure 3: Virtual Reality vs Augmented Reality
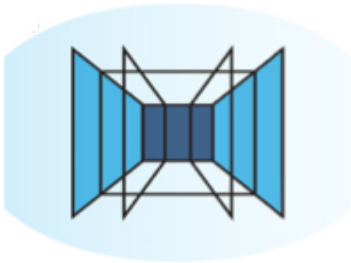
VIRTUAL REALITY

Completely digital environment
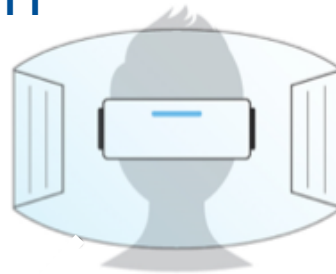
Fully enclosed, synthetic experience with no sense of the real world

AUGMENTED REALITY

Real world with digital information overly

45°F

Real world remains central to the experience, enhanced by virtual details
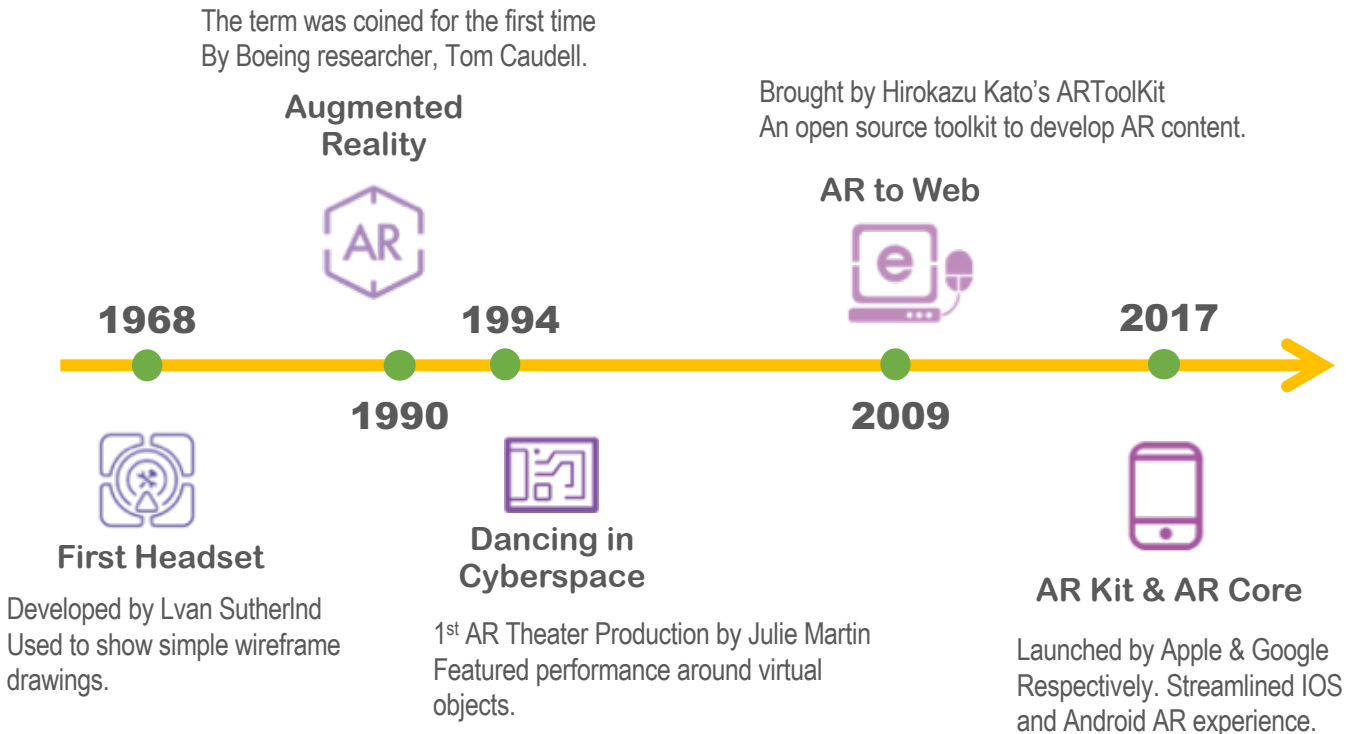
(Source: Valery)

6

Existing AR Research
Evolution of AR

It is a long way for the evolution of AR technology from the simple equipment of wireframe drawing to mobile devices. In 1968, the first headset was developed by Ivan Sutherland, which was used to show simple wireframe drawings. In 1990, the term of 'augmented reality' was coined for the first time by Tom Caudell who was a Boeing researcher. The Boeing Company hoped to help their workers by displaying wire bundle assembly schematics in a see-through HMD (Hollerer & Schmalstieg, 2016). The first AR Theatre Production, which named 'Dancing in Cyberspace', was created by Julie Martin in 1994 and it featured around virtual objects on real stage. Till 2009, an open source toolkit named *ARToolKit* could be used to bring augmented reality to website browsers. It helped to develop the AR content. ARKit and ARCore which blend digital information and physical worlds were launched by Apple and Google, respectively in 2017.

### Figure 4: Evolution of Augmented Reality

The term was coined for the first time
By Boeing researcher, Tom Caudell.

Augmented Reality

Brought by Hirokazu Kato's ARToolKit
An open source toolkit to develop AR content.

AR to Web

1968   **1994**   **2017**

1990   **2009**

First Headset

Developed by Lvan Sutherlnd
Used to show simple wireframe drawings.

Dancing in Cyberspace

1st AR Theater Production by Julie Martin
Featured performance around virtual objects.

AR Kit & AR Core

Launched by Apple & Google Respectively. Streamlined IOS and Android AR experience.

(Source: NewGenApps)

Existing AR Research
Three Key Components of AR Implement

Figure 5: Key components to realise AR Technology
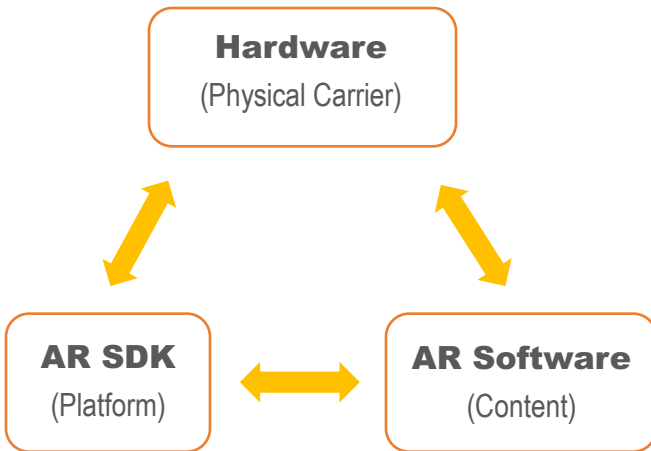
(Source: Augmented Reality Functional Requirements, 2017)

The hardware, AR SDK and AR software must work together well to make AR technology work (see Figure 5) .

● **Hardware**

The hardware refers to the smart devices which meet the functional requirements of having GPS, light adjustment, camera, and movement tracking, WI-FI connection.

● **AR SDK**

AR SDK is a set of AR software development tools that comprehend the creation of AR applications based on particular computer systems. In simple terms, it is the platform on which AR software (AR content) is created.

ARKit   **ARCore**

Apple has *ARKit* as its AR platform for a developer to create a mobile AR App on iOS system while Google developer uses *ARCore* for Android system.


● **AR Software**

AR software provides AR functions, such as AR applications on mobile devices.

Existing AR Research
The Working Process of AR

As mentioned before, AR relies on the hardware, such as smart device, as its physical carrier. Without the AR hardware, it is unable for users to get the digital information to facilitate the AR experience (Fruht, 2011). With the development of technology, AR hardware is constantly updated to support a more sophisticated experience (Craig, 2013; Xue, Bang & Sharma, 2017). Commonly, the main devices (see Figure 6) for an AR hardware can be categorized into input devices (sensors and cameras, tracker, GPS), analysing devices (computers) and output devices (displays).

Figure 6: The Working Process of AR

Input Devices	Analysis Devices	Output Devices
Sensor Camera Tracker GPS	Computers	Displays
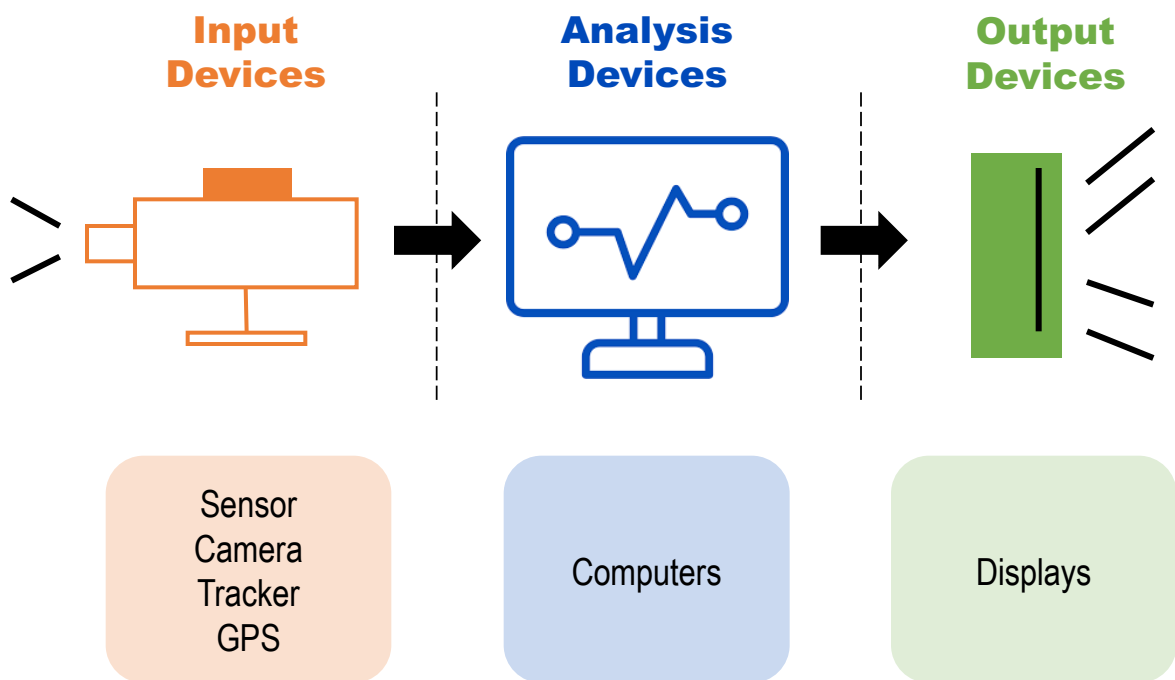
Existing AR Research
The Working Process of AR

The input device works including sensors gathering user's real-world interactions, cameras visually scanning to collect the surrounding environment and GPS tracking user's location information (Bardi, 2017).

After the input devices finish gathering information, the analysing devices (such as the computers) process the data, renders them and formulates a digital model to determine the appropriate output.

Figure 7: Microsoft HoloLens & Google Glass

Figure 8: AR Application (App) in the Smartphone

For output devices, the head-mounted display, such as Microsoft HoloLens and Google Glasses (see Figure 7), and the handheld display are the commonly used devices. The latter are small devices that the user can hold in their hands, such as smartphones and tablets (see Figure 8). Utilizing the video-see-through technique, the user can overlay graphics onto the real world through smartphones, tablets, etc. (Furht, 2011)

Existing AR Research
Three Types of AR Technology

The three types of AR refers to recognition-based (or marker-based) AR, location-based (markerless) AR and superimposition-based augmented reality.

● Recognition-based AR

Open AR app ➔ Recognize a marker ➔ Digital factors comes out

(Source: Spectre)

Recognition-based (marker-based) AR works by using a camera to sense and identify visual markers or objects, such as simple patterns like QR code or natural feature tracking (NFT) markers.

Once the object is recognized, the marker on screen is replaced with a virtual 3D version of the corresponding object. This allows the user to observe the object in more detail and from various angles. Rotating the marker would rotate the virtual replication as well. Recognition-based AR is commonly used as a marking tool for business. For example, the Brisbane Festival App could recognize the festival logo on streets and give people a taste of the festival by watching performance previews on their smartphones (Brisbane Festival, 2017).

● Location-based AR

Location-based AR relies on a GPS, digital compass, velocity meter, or accelerometer to provide data about the location, and then these inputs can activate AR visualizations (Bardi, 2017). Thanks to the widespread use of smart devices, this AR type is more welcomed and implemented.

(Source: Chen Liao)

One of the usage of this type of AR is TAMUAR, a campus navigation App in the USA. Users can use the map feature to get directions and navigate around the campus. It provides users with a list of Points of Interest (POIs), touristic landmarks, statues, and prominent buildings with visual graphical annotations which appear or are overlaid on the camera screen (Anuar, 2013).

Existing AR Research
Three Types of AR Technology

● Superimposition-based AR

Superimposition-based AR partially or fully replaces the original view of an object and adds a newly augmented view of that same object. AR emphasises the seamless superimposition of 3D virtual objects into the user's environment in real time (Sicaru, Ciocianu & Boiangiu, 2017; Lukosch, Billinghurst, Alem & Kiyokawa, 2015), where object recognition is vital in the case. Superimposition-based AR can be used in treatment and healthcare industry. Based on this technology, a doctor can thoroughly examine patient and gives a proper treatment.
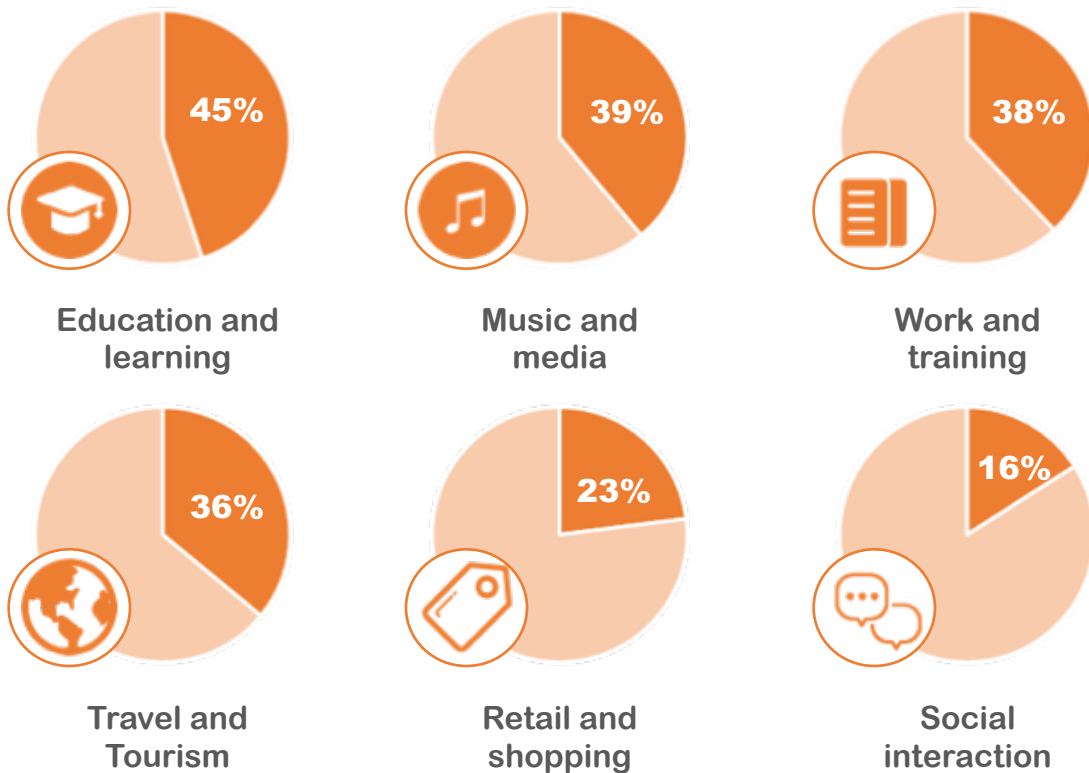

(Source: Ocular VR)

Existing AR Research
AR Adoption in Industry

AR has a bright future according to the market research. Goldman and Sachs Global Investment Research states that the predicted market size of VR/AR industry for different use cases in 2025 will reach $80 billion including both software ($35 billion) and hardware ($45 billion) (Goldman Sachs, 2016) . With the spread of the technology, AR will provide diverse opportunities in changing the people's behavioral patterns in daily life.

According to Figure 9, those non-users who also not interested in using them in the future only occupy a relatively small proportion in different industries and none of them exceed 50%. This factor can tell that AR has raise the attention of a great number of people. After that, in the tourism industry, the acceptance on VR/AR technology arrives 64% in the tourism market, which reflects the general acceptance of AR from the tourists' perspective. AR application in the tourism industry ranks third in six industries, only behind retail and social industry. With technology development, AR might be increasingly implemented in the future to satisfy the needs of the tourists.

Figure 9: Percentage of Laggards Open to Using VR/AR in Different Domains

45%	39%	38%
Education and learning	**Music and media**	**Work and training**

36%	23%	16%
Travel and Tourism	**Retail and shopping**	**Social interaction**

*Laggards: Currently non-users of VR/AR, and not interested in using them in the future.
(Source: Ericsson ConsumerLab, Merged Reality, 2017)

Existing AR Research
Most AR-Active Industries

● Education

In education sector, AR is often used to connect reality with virtual and digital contents. It is used as a tool to explain the abstract and difficult concepts, increase the interaction between the teachers and students, and assist in training (Thinkmobiles, 2018).


(Source: Virtual Speech)

AR is widely applied in various disciplines, including sciences, chemistry, geography & history, ecosystems, and language (Johnson, Smith, Willis & Haywood, 2011). For example, Anatomy 4D is a suitable AR App for medical students. By scanning printed targets, the application (App) shows 3D models of any part of human body, joints and functions, and allows users to interact with it (Anatomy, 2017).

● Healthcare

3D modelling and its ability to add digital content towards reality grants the healthcare related industry to scan patients without the need for invasive procedures (De Paolis, Ricciardi, Dragoni, Aloisio, 2011; Pandya, Siadat & Auner, 2005; Zhu, Hadadgar, Masiello, Zary & Hochheiser, 2014). Google recently revealed an AR microscope (ARM) which can detect and locate cancerous cells in real-time with the help of machine learning (UnloadAR, 2018), which could significantly decrease the time and effort of discovering and diagnosing cancer.
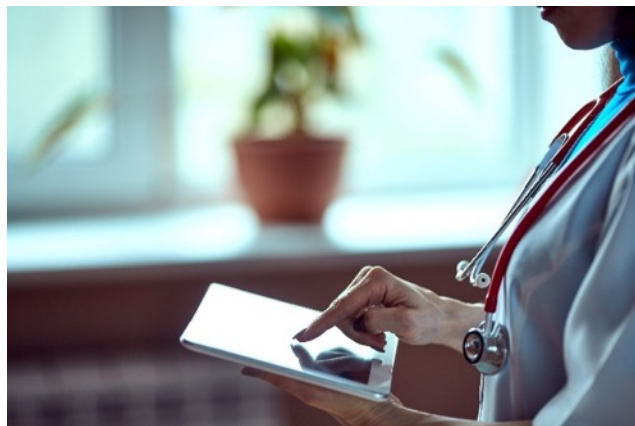
Existing AR Research
Most AR-Active Industries

● Retail Industry

AR in the retail industry is mainly used for marketing and enhancing the visitor experiences. *See the Unseen* is a mobile App designed of Nissan in the USA. Visitors to Nissan dealership showrooms could use the App installed on their smartphones to experience the advanced vehicle safety technologies through a Star Wars interactivity, which makes Nissan shopping experience much more fun, engaging and educational (VRScout, 2017). IKEA also designed *IKEA Place*, a customer-oriented App designed to help customers see what the furniture would look like in their rooms. By scanning pages in IKEA's printed or digital catalogue, users can place virtual IKEA furniture in real rooms with the help of augmented reality (IKEA, n.d.).
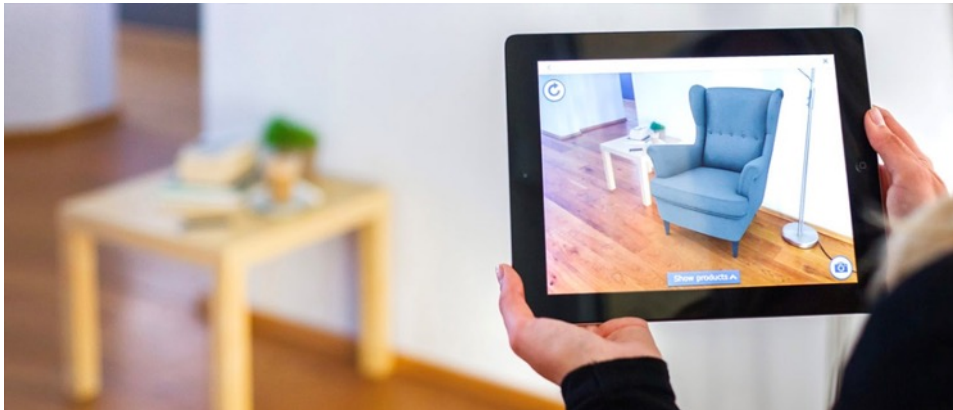
(Source: ThinkMobiles, n.d. -a)

● Entertainment and Gaming

Entertainment and gaming is one of the first players of AR technology. The game Pokémon GO changed the mobile gaming industry. The App uses location-based and superimposition-based AR to offer unique experiences by catching Pokémon in their real life.

The game leveraging Google Maps let the players use AR technology to interact with virtual targets at real-world physical occasions. Players typically do not communicate with each other directly, but often engage in either collaborative or opposing efforts.

Existing AR Research
AR Adoption in Tourism

Compared with VR which isolate users from the real environment into a virtual world, AR adds contents to the user's actual surroundings and enhances their interactive experience. The increasing AR adoption and AR applications utilization in tourism provide destinations and tourism organizations more opportunities to improve visitor experience. According to Yung and Khoo-Lattimore (2017), most studies of AR in tourism focus on the tourism experience enhancement. The newly developed AR applications create unique visitor experiences by offering tourists interesting and valuable information (tom Dieck & Jung, 2018). Globally, AR technology is gradually adopted by many tourism destinations and travel related business.

(1) Navigation and Wayfinding

Thanks to location recognition and environment understanding, AR can firstly be used to help visitors find their path in a destination, such as finding restaurants, restrooms, and understanding the layout of attractions. Regardless of locating the surroundings of the visitors, AR Apps can also help offer extra information based on their location.

(Source: Pointr)

Existing AR Research
AR Adoption in Tourism

(2) Bring history to life (see Figure 10)

This type of AR Apps are widely used in historical and cultural destinations. Many of them could bring the history "back" to visitors, which not only increase visitors' engagement, but also help in educating visitors. For some heritage sites which have delicate and fragile attractions, AR is an alternative which can showcase the exhibitions to the visitors. Besides cultural destinations, some natural destinations also use this type of AR to increase visitors' experience.

(3) Interactive educating experience (see Figure 11)

AR can facilitate the process of visitors getting knowledge from their travel. It also provides an excellent chance for tourism operators to increase visitor engagement and interaction. Museums can be considered as the entities that share the characteristics of both tourism attractions and educational institutions.

AR can be a useful multi-dimensional tool in education to deliver knowledge, since the technology provides a tangible interface which stimulates both mental and physical activities through intuitive interaction with unfamiliar content. Many museums around the world have tried to apply AR technology for illustrating exhibitions and showing engaging videos and pictures to increase enjoyment.

Figure 10. Bring History to Life
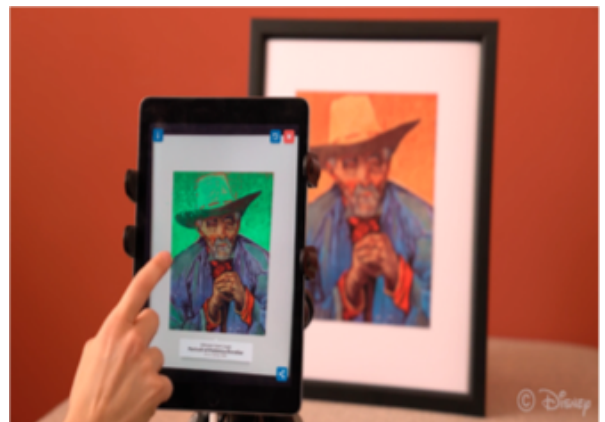(Source: ThinkMobiles, n.d. -b)

Figure 11. Interactive Educating Experience

Existing AR Research
AR Adoption in Tourism

(4) Gamification

By using location-based AR, outdoor games can be combined with onsite visiting to offer visitors a more engaging and interesting experience.

AR gaming could encourage physical activity by leveraging real-world locations and objects as part of the immersive gameplay. Different scenarios can also be applied to the tourism domain to increase flexibility and provide highly customized virtual information.

In fact, location-based AR games have already been proved motivating and engaging for tourists. One interesting example is *TimeWarp*. It is a German video game where people interact with the city and experience its temporal changes by jumping into time portals. It also educates people about different historical events by providing augmented information such as its background story, which links to small elves in Cologne traditional tale.

Current AR Application in the Tourism Industry

Current AR Application in the Tourism Industry

The research team did some random research on the Internet. Currently, AR Apps have been used by many countries in the tourism sector. Most of them are European, Oceanian, Asian, and North American countries. The geographic details are demonstrated below.

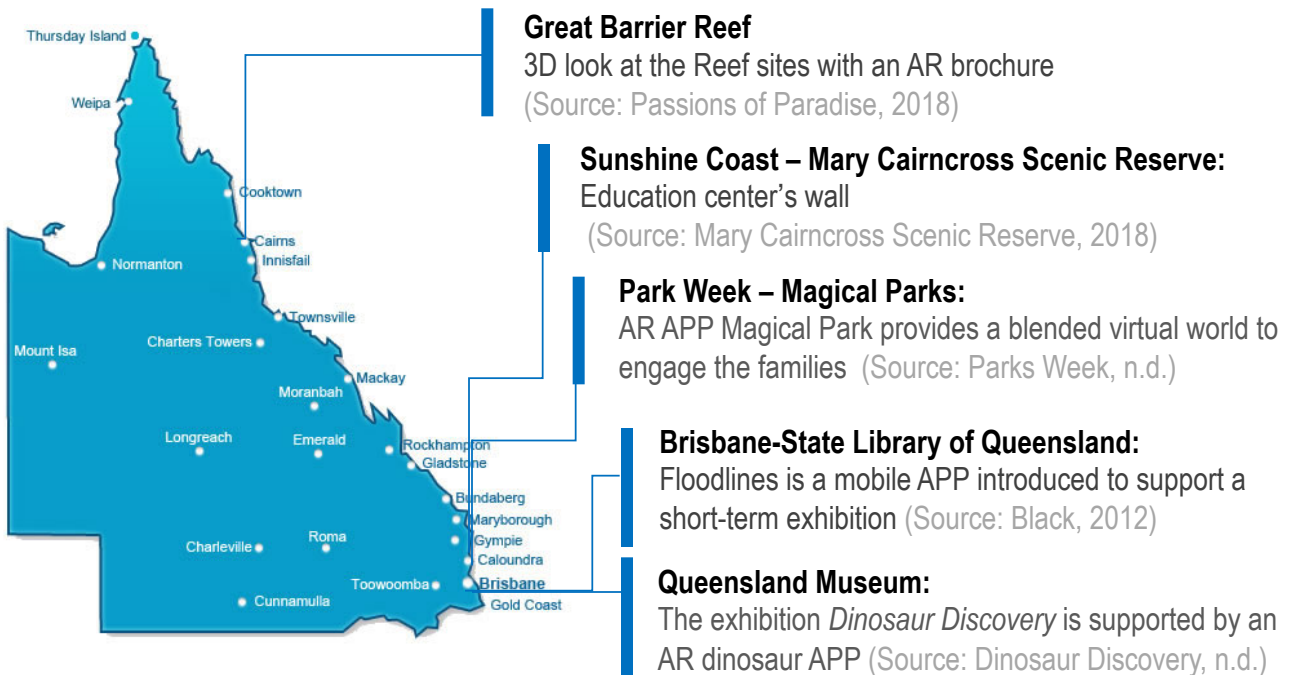**Figure 12: Global AR Application in the Tourism Industry**

- 🟢 Navigation and Way-Finding
- 🟠 Bring history to life
- 🔵 Interactive educating experience
- 🟣 Gamification
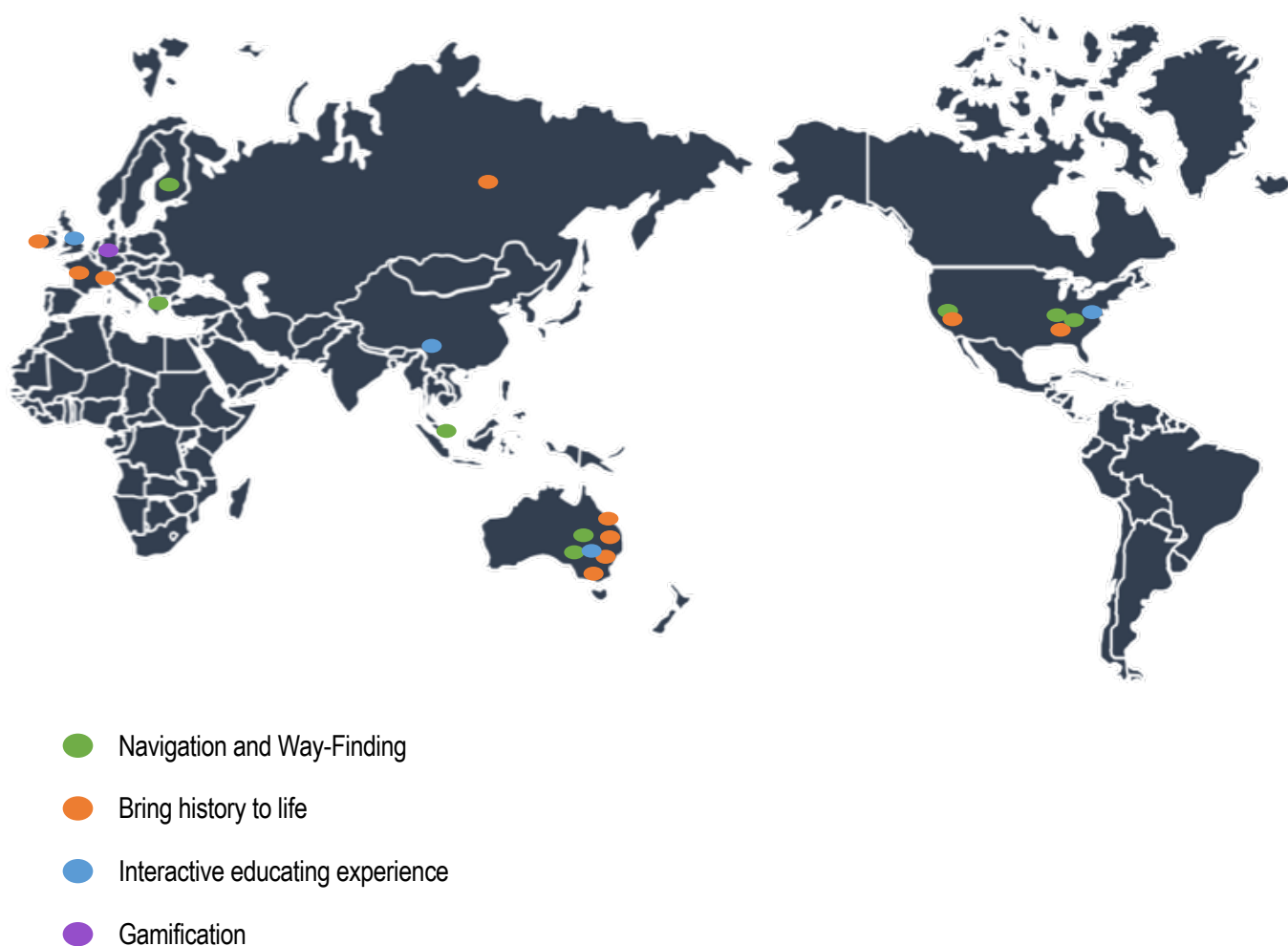
Current AR Application in the Tourism Industry

Current Uptake by QLD Tourism Industry

AR has gradually been applied in the tourism industry both globally and domestically. Following the trend, diverse bodies from Queensland tourism industry also take actions to use AR to enhance the onsite visitor experience.

Figure 13: AR Uptake by QLD Tourism Industry

Great Barrier Reef
3D look at the Reef sites with an AR brochure
(Source: Passions of Paradise, 2018)

Sunshine Coast – Mary Cairncross Scenic Reserve:
Education center's wall
(Source: Mary Cairncross Scenic Reserve, 2018)

Park Week – Magical Parks:
AR APP Magical Park provides a blended virtual world to engage the families (Source: Parks Week, n.d.)

Brisbane-State Library of Queensland:
Floodlines is a mobile APP introduced to support a short-term exhibition (Source: Black, 2012)

Queensland Museum:
The exhibition *Dinosaur Discovery* is supported by an AR dinosaur APP (Source: Dinosaur Discovery, n.d.)

AR technology is tried out by most of the sub-sectors belonging to the tourism sector. There are some characteristics shown regarding AR application.

Characteristics and Issues of AR in QLD Tourism

First, it is mainly used by the government supported bodies or the bodies with sufficient financial support. The small and medium tourism operators are not actively involved in AR application yet. Second, for the tourism attractions, the AR application is still limited regarding the way it is used, though it is also subjected to the attraction's type. Another characteristic is the museums and exhibitions actively use AR to deliver a better experience, but the process lacks consistency both in time and space. For example, the mentioned exhibitions in the museum are temporary exhibitions which the AR application cannot benefit the museum in the long run. On the other hand, the scenic reserve only implements AR by scanning the wall with the iPad provided while there are still chances to offer a more sophisticated AR experience.

Current AR Application in the Tourism Industry
Chances of AR in QLD Tourism Industry

Following the previous discussion, there are some chances where the QLD tourism industry can deliver a better experience with the AR application. We have provided two case studies to investigate deeper insights into AR App implementation.

Case Study 1 - Jinsha Site Museum (Chengdu, China)

Found in 2001, the museum is an archaeological site of the ancient Shu Kingdom dated back to 12th to 7th century B.C.

The museum is established on the ruins of Jinsha Site, where various artefacts were unearthed in large numbers, including thousands of artefacts of gold, bronze, jade, ivory, etc. (Jinsha Site Museum, n.d.).

The two main architectures of the museum are the Relic Hall, the Exhibition Hall. The Relic Hall is used for site protection and demonstration, while the Exhibition Hall mainly provides permanent exhibitions to introduce the sites, relics and the knowledge related to Jinsha's past and prosperity.

Current AR Application in the Tourism Industry
Chances of AR in QLD Tourism Industry

Onsite AR Application of Jinsha Site Museum

Three mobile applications are used to facilitate the onsite experience utilizing AR technology.

Figure 14: Jinsha Site Museum AR Apps

	Working Status	Description/ Function
The Jinsha Site Altar AR (149.1 MB)	❌ (require an upgrade to iOS11)	● Supported by the museum. ● Using the smartphone camera to identify the target can allow the mobile phone to load the Virtual Reality scene which restores the disappeared buildings.
The Jinsha Site Museum (251.1 MB)	✅	● Not supported by the museum. ● After scanning the pictures on the postcard, the 3D relic will appear on the smartphone interface and audio commentary will be automatically played. The user can use fingers to adjust the angle of the remnant and take pictures with it.
Jinsha Smart Guide (31 MB)	The App works with an AR function page. However, the AR function is not put into practice currently.	● Supported by the museum. ● Functions include exhibits guide, map guide, AR interaction, Jinsha Community, user center, etc.

(Source: Chengdu Cultural Heritage Informationsql_injectionConsulting, n.d.; Touch culture media (Beijing) co., LTD., n.d. ;Tianjin Hengda Wenbo S.&T.Co. LTD.,n.d.)

Current AR Application in the Tourism Industry
Chances of AR in QLD Tourism Industry

Facilitating Equipment and Platform

Wi-Fi coverage and WeChat platform are the two primary factors perceived that promote the AR experience onsite.

The Museum provides full Wi-Fi coverage in the halls, which allows the visitors to download the App at any time with ease. At the same time, Webchat is one of the most famous social media platform in China and the WeChat official account have becomes a common way for business entities to communicate with their customers.

The QR code of the Museum App is provided both on the WeChat official account of the museum and at the limited spots on site, trying to avoid the dilemma of widely spread placement of different QR codes.

Potential Problems

App file size

App file size is a big issue that needs to be solved. According to the table, the Apps including digital communication function and AR function, which all require large storage space. The third App has not been added AR functions yet, so the file size remains a question in the long run. In this sense, the App file size not only brings the challenge to downloading, but also sets a requirement on the storage of the mobile phone. There should be a choice between downloading an App at once with a large file size and downloading a small size App which continually loads the data while using the App. The Museum may take the decision based on its own condition.

Marketing strategy

The strategy applied by the Museum may largely influence the visitors' awareness on the AR App. While exploring the official website as well as its WeChat official account, the information related to the function is currently quite limited. The Jinsha Smart Guide App is demonstrated in the official account, but it is only attached at the end of the articles after the user has already read some of the content (see Figure 15).

Current AR Application in the Tourism Industry

Chances of AR in QLD Tourism Industry

The perception of the App existence is not quite outstanding, and there won't be any specific benefits of downloading the App shown to the visitors. The absence of AR function might be a potential reason for not marketing the App correctly, but the Museum needs to reconsider the strategy to let the visitors be aware of the App.

Figure 15: WeChat Official Account Interface
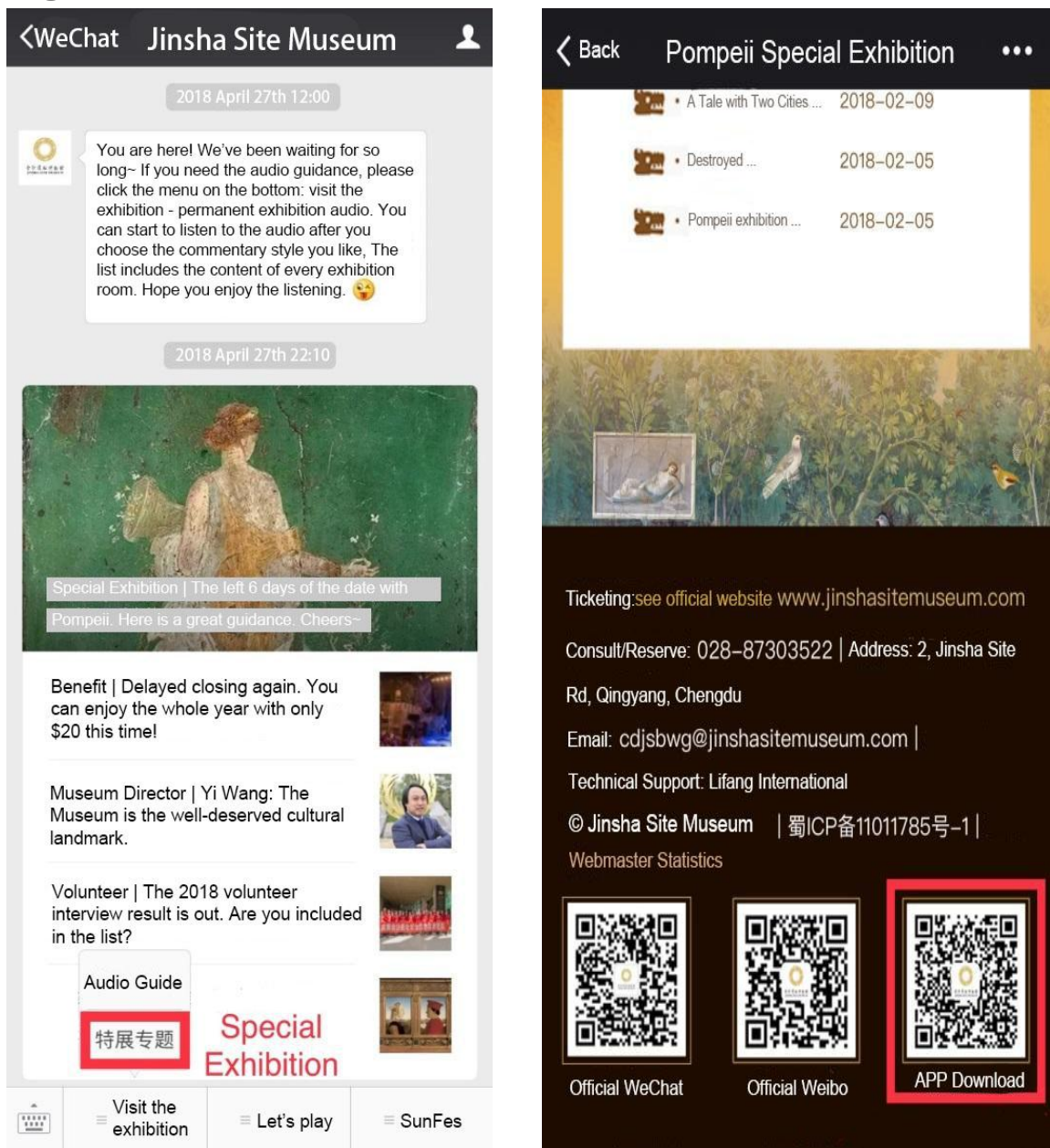
* The visitors can only find the App QR code after clicking the Visit the Exhibition - Special Exhibition corner and dragging down to the end of the page. They cannot find the QR code elsewhere by clicking other links.

Current AR Application in the Tourism Industry
Chances of AR in QLD Tourism Industry

Implication

- App file size should be evaluated based on the tourism body's needs where pros and cons both exist.

- The tourism operators who design their own Apps should accompany the App with a proper marketing strategy to increase the awareness of the visitors to the AR App.

Opportunities in the Museum- AR Portal

With the fast development of AR technology, the new ideas also bring the opportunities to the Museum AR App. In this case, the concept of AR Portal can be introduced to develop the visitors' further onsite experience.

With the help of the App, the visitor (standing as the red person) can hold his mobile phone to scan the environment and try to explore the restored scene from different angles by using the control button on the screen.

In the App, though the visitor can have a general understanding of the architecture, he can only observe the appearance.

(Source: Jinsha Site Museum, n.d.)

Current AR Application in the Tourism Industry
Chances of AR in QLD Tourism Industry

However, the AR Portal developed by *ARKit* which is supported by Apple can take the idea of this App a step further.

An iPhone made the screenshot and a virtual door is superimposed on top of the real world and the road leads to a virtual jungle. The door remains where it is even though the camera moves around.

With the AR Portal application, the visitor's demand of exploring the inner side of the architecture will be possible, and this can integrate the visitors' onsite experience to a higher level.

(Source: Nedd, 2017)

Current AR Application in the Tourism Industry
Chances of AR in QLD Tourism Industry

Case Study 2 - Ingress

One of the most famous augmented reality mobile games in the world is *Ingress*. Developed by Niantic, Ingress is a GPS based game but also can be considered as an exergame. The game has been downloaded more than 11 million times till 2015, and is played globally, i.e. North America, Europe, and the Middle East (Smith, 2015).

Furthermore, more than one million active daily players are congregating outside in groups to play the game. Based on its science fiction background story, the players need to play a role in the game, and compete with other faction by capturing portals in the real world.
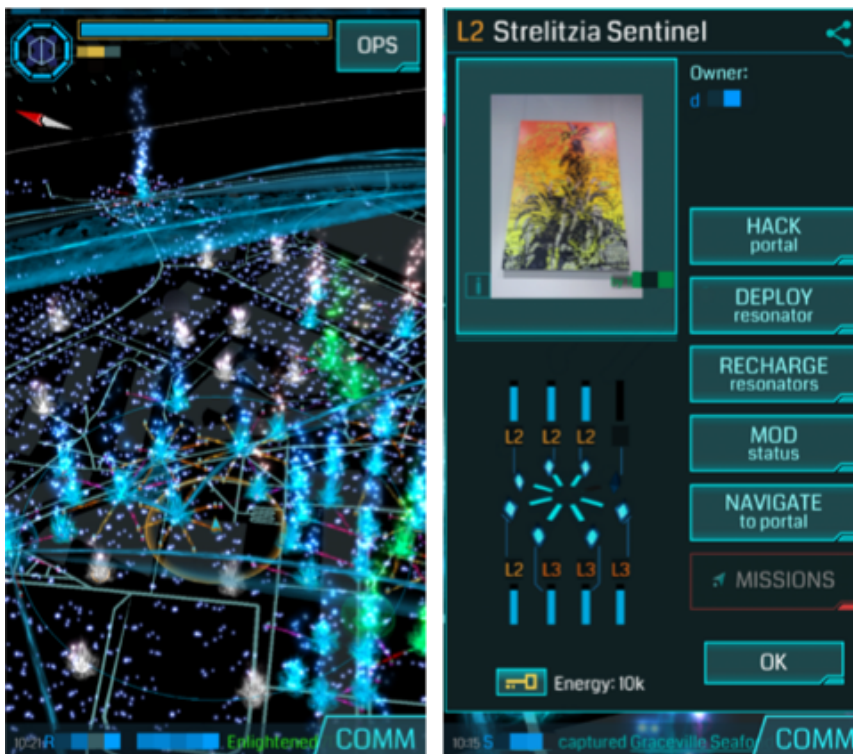
As a massive multiplayer mobile game, Ingress needs its players to walk around and interact with physical objects to collect the units of energy, control portals, destroy portals controlled by competitors, and capture territories for their team.

Current AR Application in the Tourism Industry
Chances of AR in QLD Tourism Industry

It seems that the gameplay consists of two phases, namely collect and control, but the players need to adopt a series of strategies to play the game. Portals are the central part of Ingress and will appear at the places such as historical architectures, artworks, and city landmarks.

Within the game, there are two opposite factions: the Enlightenment (green team) and the Resistance (blue team). It represents utterly different attitude towards Exotic Matter which is associated with the aliens. Under this background, Ingress requires the player to play as an agent and join one team.

The gameplay of Ingress can be considered as a combination of geocaching and capturing the flag (Davis, 2017). The player can see portals, energy, links and other items on the screen when they are using the mobile application. However, the free movement, especially outdoor movement, plays a pivotal role in the game. In the process of using phones, people need to not only search the objects on the map but also interact with them. Except for the daily competition between the factions, players can attend in anomalies which are kinds of special events held on specific dates. They can get rewards and badges for themselves and points for their faction.

Current AR Application in the Tourism Industry
Chances of AR in QLD Tourism Industry

Impacts of application

(1) Storytelling

To enhance immersion, the developers from Niantic wrote an attractive story with the opened narrative. Niantic regularly builds the in-game storyline, updates the videos and holds special activities to keep the game running. When players use the App, they will experience the line the story and the reality getting blurred. All the things they did in the real world will be a part of the story.

Another implementation is that regardless of the pictures, the description around the portal will be demonstrated if the player clicks on the photo. The description editing and the portal creation are all opened to the players and the developers will check after the changes are submitted. Thus, it provides the flexibility to the players to build the virtual world collaboratively, and in turn, increases the likelihood of the visiting of the players.

(2) Navigation

For some people, Ingress is a good tool to understand a place. On the one hand, the residents have an incentive to explore their city. They may like to visit more attractions such as parks, museums and galleries to gain badges. On the other hand, the travelers can get the information about the destination, and will spontaneously walk and explore the local attractions.

After that, the players can also create Mission, which links several spots together. This function may provide insights on arranging the routes at the tourism attraction.

(3) Community establishment

It is beneficial for strengthening the relationship between players and the community. When a player joins one team, he or she fights for the team instead of themselves. Ingress players think that they are playing in a community rather than a group. In addition, Ingress encourages players to build their own community in Google+. The community belongingness can be reinforced through experience exchange, strategy discussion and collaboration in the real world.

Current AR Application in the Tourism Industry
Chances of AR in QLD Tourism Industry

Critics on the Game   **Information Safety**

One important issue needs to be considered is personal information safety. Based on GPS technology, the player's location and the time to play the game are demonstrated and recorded. Therefore, personal information in terms of the range of daily activities might be easily figured out by collecting geographic data shown on the screen.

Implications for QLD Tourism

- The designer should consider how to present the information of the attractions. Using attractive ways to draw the tourists' attention is the core of design philosophy.

- The navigation of QLD scenery in the form of the game may be attractive to the young generation.

- To increase the interaction between virtual information and real objects can reinforce their feeling towards the tourist destinations.

- The designer also should think about how to protect personal information safety when the tourists are using the App.

Current Government Support in AR Adoption

Current Government Support in AR Adoption
Global Government Support

AR technology development wins the attention globally, but each country may have its own approaches to impede AR technology adoption. Several representative cases are listed below.

Department:
General Services Administration

USA

Program/Case:

"GSA's Emerging Citizen Technology Office launched the Federal Virtual/Augmented Reality Program in October 2017 to serve as a collaborative hub for the research and refinement of VR and AR Business Cases and pilot programs across government.

Federal agencies will share their ideas on how VR/AR can expand and improve their service in terms of medical care, education or disaster management, etc. The government may host workshops to facilitate brainstorming between agencies and industry specialists and demonstrate the new technologies." (U.S. General Services Administration, 2018)

UK

Department:
Tourism Northern Ireland, Department for communities, Digital Catapult Northern Ireland and Matrix (Northern Ireland Science Industry Panel)

Program/Case:
"Theses organizations have up to £70,000 to invest in projects that test how AR can improve the way tourists experience the country. The industry organization can apply a share of £70,000 to develop AR technologies that help tourists to plan and enjoy their visits." (Innovate UK, 2017)

Innovate UK (part of UK Research and Innovation, a non-departmental public body funded by a grant-in-aid from the UK government) (Innovate UK, n.d.)

According to the government record, many programs are well supported by Innovate UK covering AR technology adoption in the aspects of medical care, tourism, machine learning, etc.

Current Government Support in AR Adoption
Global Government Support

Department:

The Government of Canada

Canada

Program/Case:

"Built in Canada, Innovation Program helps Canadian innovators land their first sale and have their innovations tested by the Government of Canada. This program is just one of the many ways the Government of Canada supports innovation and small and medium-sized businesses across Canada.

This project supports a platform which work with Canadian Heritage to produce location-based, augmented reality experiences in the nation's capital." (Public Services and Procurement Canada, 2017)

Department:

Central Government of China

China

Program/Case:

Based on the *Guideline on Emerging Sectors of Strategic Importance during the 13th Five-Year Plan period (2016-20)*, the government will provide policy support and financial assistance to the industries closely related to VR/AR. The government forms research and development laboratory to support the VR/AR industry development. (Fink & Steiber, 2017)

Current Government Support in AR Adoption
Global Government Support

Regardless of other countries, the local governments and associations also start to try out AR Apps to both marketing themselves and facilitate the delivery of visitor experience.

**Figure 16: QLD Government Supports on AR**

Bodies	Information released date	Type	Functions
Gold Coast Tourism Corporation	July 29, 2013	Mobile App	The Gold Coast Traveler mobile App has an AR setting called GC Lens which displays products, experiences, and offers around the users through the camera screen on the devices.
Tropical North Queensland	December 19, 2013	Mobile App	The Tropical North Queensland mobile App is a free official guide to this specific region. All information including maps, augmented reality and travel content is accessible.
McKinlay Shire Council,	November, 2017	Tourism plan	In the 5-year action plan, the council will research and identify quotation for delivery of augmented reality experience in year 1.
Redland City council	2015	Tourism plan	In the Redland City Tourism Strategy and Action Plan 2015-2020, the council decides to offer AR tours to deliver an interactive and flexible experience introducing the Indigenous and other history of the Redlands.
Outback Queensland Tourism Association	2017	Tourism plan	The Association intends to support the development of new interactive Palaeotourism experiences including VR and AR in 3-5 years.
Sapphire Gemfields	August, 2017	Interpret-ive trail	Visitors can take themselves on a historical journey through the four townships of Queensland's Sapphire Gemfields. The interpretive signs incorporate AR with multi-media and solar-powered audio features, used to display the unique stories of the destination.

(Source: Innovative Gold Coast Traveler App: the Ultimate Travel Companion, 2013; Douglas Shire Council, n.d.; McKinlay Shire Tourism Plan, 2017; Outback Destination Tourism Plan 2017-2020, n.d.; New Path of Discoveries, 2017; Central highlands Queensland, n.d.)

Current Government Support in AR Adoption
Global Government Support

Compared to the industries bodies, governments and associations hold relatively conservative idea to AR technology implementation. Differing from those industry bodies who have already built the Apps, the governments and associations are still in the planning stage to take actions. However, as can be seen from the cases, the governments and associations also hold a positive idea regarding AR technology implementation in the near future.
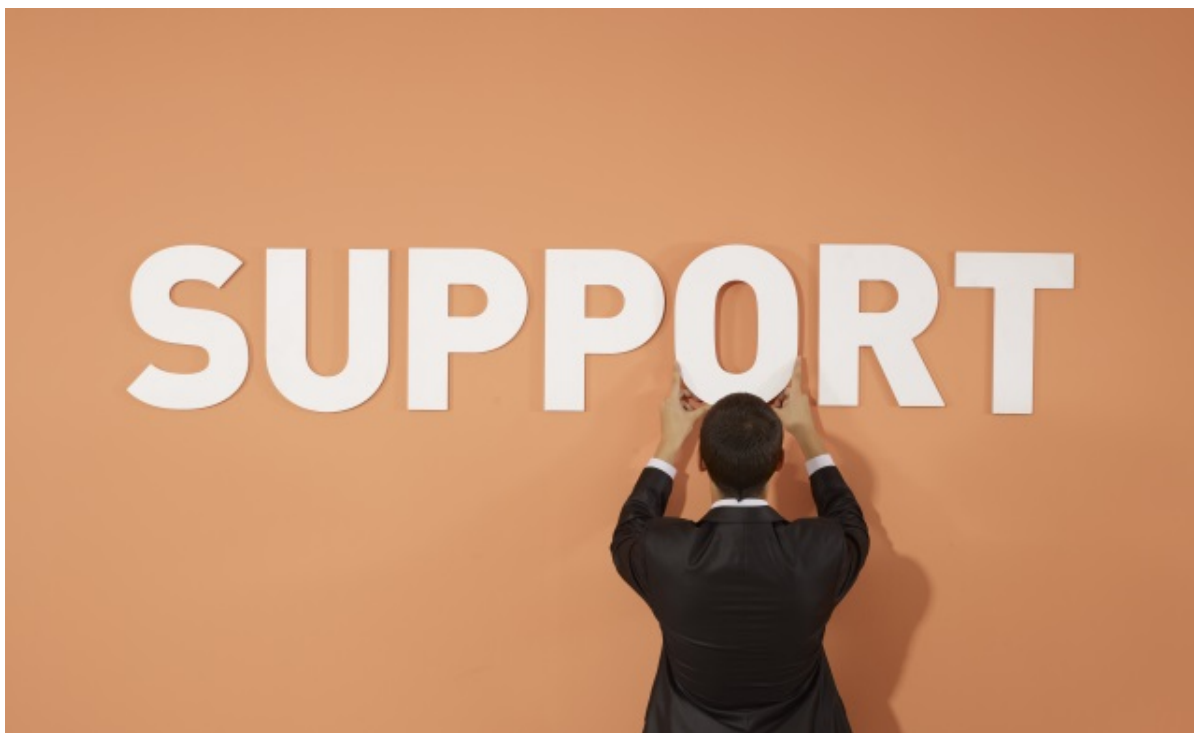
Current Government Support in AR Adoption
Existing Programs in Jurisdictions

● Within the Queensland Government

Several programs are carried out for those who are interested in exploring or investing in AR technology.

DITID runs some programs to facilitate the small and medium businesses who are interested in studying and applying AR. Firstly, the *Small Business Digital Grants Program* is an ideal grant to access digital technologies and services that help the operation of the business (2018). Covering from $1,000 up to $10,000 (excluding GST), the funding may be provided for the purchase of hardware, software and services. The Queensland Government's Office of Small Business also provides grants on offering up to $50,000 (excluding GST) for small and medium businesses that show high growth and employment aspirations (Trade and Investment Queensland Australia, 2018). The fund will provide successful applicants the chance to purchase and implement specialized equipment or services to help them seize growth opportunities. Based on these programs, small or medium businesses in the tourism industry with the good operating condition may have the chance to apply for the grants to facilitate its AR adoption process.

At the same time, Innovate Queensland holds webinars to introduce innovative technologies such as VR and AR to the industry leaders, especially the small and business enterprises (SMEs) leaders. By working closely with the government, SMEs may have the chance to find their opportunities in AR technology adoption.

Another chance is that, though not directly linked to tourism, AR development is supported by Advance Queensland in the screen industry. In terms of developing the content, application and the corresponding marketing strategy of the QLD tourism industry, the collaboration possibilities can be searched in this field (Department of the Premier and Cabinet, 2017).

Current Government Support in AR Adoption
Existing Programs in Jurisdictions

● Other Governmental Programs in Australia

Except for the Queensland Government, other state governments also take actions, and the Queensland Government may learn from their strategies as well.

Creative Victoria is a state government body that supports Victoria's creative industries. It launches a biannual program called **Rockin' the Laneways** with maximum $25,000 funding (Creative Victoria, n.d.; Grant Guru, n.d.). This program aims to support the project that highlight Victoria's popular music history, attract cultural tourism and encourage people to explore Victoria's rich music history. The program specifically mentions the eligible activities of the program including VR, AR or other digital projects that helps to discover more about Victoria's music heritage.

The Northern Territory Government also behaves actively in AR technology adoption. **The Business Innovation Support Initiatives program (BISI)**, managed by the Northern Territory Government's Department of Trade, Business and Innovation, provides vouchers and grants to innovators (Northern Territory Government, 2016). A company called JCTK Investments developed a tourism App called ExploreAR360, integrating AR and 360-degree VR with online travel booking systems. The company was awarded a $60,000 grant under the BISI program to develop the App. Another case is that Northern Territory Government grants $24,420 as Tourism Infrastructure Development Fund to Djiplin Arts to convert its culture centre into a permanent museum attraction (NT News, 2018). As part of the experience onsite, an AR tour will detail the cultural traditions behind the Blanasi paintings. Thus, part of the funding will be used to purchase infrastructure for the augmented reality tour.

Though not mentioning a explicit program that facilitates digital application, Southern Tasmania Government also tries AR technology adoption. For example, a $100,000 AR project was launched which would provide the tourists with the experience of seeing Tasmanian tigers going through the bush (Robertson, 2017). This project is funded by Southern Midlands and Derwent Valley councils with some state government money. Destination Southern Tasmania advocated the project. The council tends to improve the visitor's experience by applying small beacons at sites. They may see the stories behind the reality with the help of AR technology, 360-degree video, etc.

Current Government Support in AR Adoption

The Supply Side of AR Adoption in QLD Tourism Industry

The supplies provided by many companies can be used in the tourism industry regarding using the applications to create the onsite experiences. Currently, several suppliers in Queensland develop and produce Augmented and Virtual Reality devices and software. They can also help in creating and delivering experience. Some companies provide different Apps which can help startup businesses.

Lightweave

Experiential creators.
They help tell stories by licensing unforgettable experiences and offer location-based AR for onsite consumer engagement. Their product, the Licensable Collection is an index of licensable virtual and augmented reality content ready to be rebranded and adapted to any campaign. They also provide brands with customizable engagement content (Lightweave, n.d.).

Immerseport

VR+AR+360 degree
This company develops augmented reality Apps with subscription-based content which can be updated as required (immerseport, n.d.).

Think Virtual Reality

This company builds innovative solutions for both the government and private sectors. They have a team of designers, coders, videographers, and developers. They are production expertise and do in-house programming, game development, 3D asset and modelling and designing (think virtual reality, n.d.).

Current Government Support in AR Adoption

The Supply Side of AR Adoption in QLD Tourism Industry

Activate Entertainment

This company creates content including Film, video, 2D/3D animation, Apps, augmented reality, virtual reality, 360 image/video, illustrations, graphic design, illustration, hand-drawn animation etc. (Activate entertainment creates content, 2018).

One VR

It is a software developing company focusing on creating virtual marketing applications. It has been producing AR applications since 2012. These allow users to engage with the environments to interact with virtual information (ONEVR, 2015).

Q1 design

They are the creators of digital experiences and have a knowledge of technology solutions. They design and create experiences with reliable and simple to use technology as a backbone (Q1 design, 2018).