IDENTIFYING CRITERIA FOR THE IMPLEMENTATION OF AUGMENTED REALITY IN MALAYSIAN TOURISM INDUSTRY

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TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

AR	Augmented Reality
DBKL	Kuala Lumpur City Hall
CMS	Content Management System
USM	Universiti Sains Malaysia

MENGENALPASTI KRITERIA UNTUK PELAKSANAAN REALITI TERIMBUH DALAM INDUSTRI PELANCONGAN MALAYSIA

ABSTRAK

Sektor pelancongan adalah salah satu sektor terpenting bagi Malaysia. Untuk memajukan sektor pelancongan, teknologi Revolusi Industri Keempat harus dimanfaatkan. Ini telah terbukti dapat dilaksanakan oleh banyak penyelidik di seluruh dunia. Namun, saat ini kekurangan maklumat mengenai penggunaan teknologi Revolusi Industri Keempat dalam industri pelancongan Malaysia. Jenayah seperti penyeluk saku juga merupakan kejadian biasa di Kuala Lumpur, oleh itu cara memberi amaran kepada pelancong mengenai titik panas jenayah adalah penting, kerana kejadian seperti itu akan memberi kesan negatif terhadap pengalaman mereka mengunjungi Malaysia. Tiga isu utama yang akan difokuskan dalam penyelidikan ini adalah meningkatkan pengalaman navigasi berjalan kaki pelancong yang berkunjung ke Kuala Lumpur, meningkatkan keselamatan pelancong secara keseluruhan dan meningkatkan kaedah pemasaran semasa DBKL (Dewan Bandaraya Kuala Lumpur). Penyelidikan ini bertujuan untuk mengkaji kemungkinan mengintegrasikan teknologi Revolusi Perindustrian Keempat ke dalam industri pelancongan Malaysia untuk menyelesaikan masalah yang disebutkan. Prototaip aplikasi bernama My-ARt dikembangkan setelah memperoleh keperluan sistem. Prototaip My-ARt yang terakhir bertujuan untuk menyelesaikan masalah navigasi, pemasaran dan keselamatan pelancong yang disebutkan sebelumnya melalui Realiti Terimbuh.

Kata Kunci: Realiti Terimbuh, Teknologi Revolusi Industri Keempat, prototaip, pelancongan, Malaysia

IDENTIFYING CRITERIA FOR THE IMPLEMENTATION OF AUGMENTED REALITY IN MALAYSIAN TOURISM INDUSTRY

ABSTRACT

Tourism sector is one of the most important sectors for the Malaysian. To advance the tourism sector, the Fourth Industrial Revolution technologies should be utilised. 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 pickpocket is also a common occurrence in Kuala Lumpur hence a way of alerting the tourists of crime hotspots is important, as such events could negatively impact their experience visiting Malaysia. The three main issues that would be focused in this research is improving the walking navigation of tourists visiting Kuala Lumpur, to improve 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. A mobile application prototype named My-ARt is developed after obtaining the system requirement using literature review. My-ARt is then further improved upon interviewing 20 participants and coding their responses. The final My-ARt prototype aims to solve the navigation, marketing or events and tourist safety issues previously mentioned via Augmented Reality (AR).

Keywords: augmented reality, fourth industrial revolution, prototype, tourism, Malaysia

CHAPTER 1

INTRODUCTION

In this chapter, the Industrial Revolution would be briefly discussed and the impact of it towards the modern technology domain. This discussion would also give an overview of the nine core technologies under the Fourth Industrial Revolution (4^{th} IR). The core technology that is focused on in this research is Augmented Reality (AR). An overview of Augmented Reality is given in this chapter, this includes its usability. The importance of the tourism sector at a global scale and Malaysia is also discussed. Chapter 1 also provides a brief explanation of how the augmented reality technology can be utilised to improve the tourism sector along with examples of similar research to further discuss this aim.

1.1 Overview of the 4^{th} IR and Augmented Reality

The First Industrial Revolution took place between the 18th to 19th century in Europe and North America. This was a period when mostly agrarian, rural societies became industrial and urban. The Second Industrial Revolution lasted between 1870 to 1914 and was focused on growth of pre-existing industries and expansion of new ones, such as steel, oil, and electricity, and used electric power to create mass production. The Third Industrial Revolution started during the 1980s and is ongoing. This period refers to the advancement of technology from analog electronic and mechanical devices to the digital technology available today. 4^{th} IR is built upon the on the Third Industry Revolution, representing new ways in which technology becomes embedded within societies and even the human body (Zhou, Liu, & Zhou, 2016).

4th IR is an overarching industrial transformation that covers every aspect of industries and economic activities including every aspect of living (MITI, 2019). There are nine main pillars of the 4th IR which are Autonomous Robots, Big Data Analytics, Cloud Computing, Internet of Things (IoT), Additive Manufacturing (3D Printing), System Integration, Cybersecurity, Augmented Reality (AR) and Simulation (MITI, 2019).

One of the 4th IR nine pillars which is AR allows for the ability of overlaying virtual elements on top of the physical plane. This can be achieved by utilising any form of mediator such as a mobile cyber physical system or smartphone. Hence, AR allows for additional information being added on screen virtually (Williams, Yao & Nurse, 2017).

Augmented Reality (AR) can be implemented in various sectors, with the prominent one being the manufacturing sector. In the manufacturing sector, workers are given training utilising AR, hence reducing the need of a trainer. The workers can utilise their smartphone to view virtual information presented through the smartphone's camera. Hence, the trainer would not require to attend to each trainee, reducing both effort and time.

1.2 The Importance of Tourism Sector in Global Perspective

At a global scale, tourism is a main source of income for different countries that enhances the economy of both guest 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 contributes 9.9% of the world gross domestic product and is expected to increase to 10.5% by the completion of 2018 (Raza et. al., 2017).

As an example, in Japan, the number of tourists has increased since 2018. According to the Japan National Tourism Organisation, compared to the month of January in 2018, the number of tourist arrivals has increased by 7.5 % in January of 2019. Japan has also revised their tourist's arrival goal from 20 million to 30 million due to the upcoming 2020 Tokyo Olympic games (Henderson, 2016). Another example of a country with increased tourism activity is Singapore. During the first quarter of 2017, Singapore has experienced 4 % increase in international tourists' arrival, hence reaching 4.3 million in number. While visiting Singapore, tourists has also spent 6.4 billion Singaporean dollars in tourism receipts, contributing to Singapore's economy (Singapore Tourism Board, 2017).

In Malaysia, tourism is one of the most important sectors. In 2017, 25.95 million tourists have 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 continued its significant contribution to Malaysia's economic growth with a share of 14.9 per cent in 2017 (Bernama, 2018). This information reveals the importance of tourism sector to Malaysia's overall economy growth.

Hence, due to the significance of the tourism industry in Malaysia, it is only natural to adhere to the 4th IR to move forward. Like all sectors that undergoes the 4th IR, the Malaysian Tourism could benefit greatly with technologies such as Cyber Physical System and embedded technologies. These technological advances would benefit both the tourists and the government. The government has taken up several initiatives in order to transform the tourism sector in Malaysia to adhere to the 4th IR. One of the initiatives is dubbed Smart Tourism 4.0, where it is a tie up between Malaysian tourism and Tencent (Tan, 2018).

Tencent defined smart tourism as the use advanced technologies such as Big Data and the Internet of Things to improve the tourist's experience. Both Big Data and Internet of Things being the two of Fourth Industrial Revolution's core principles. Examples of Tencent's product that leads this endeavor are the mobile application WeChat, which handles user communication along with hassle free payment functions and QQ, Tencent's very own digital platform to book accommodations and making travelling plans (Tencent, 2019)

1.3 Utilisation of Augmented Reality in Tourism Sector

As previously mentioned in section 1.1, AR can be implemented in various sectors, with the prominent one being the manufacturing sector. In the manufacturing sector, workers are given training utilising AR, hence reducing the need of a trainer. The workers can utilise their smartphone to view virtual information presented through the smartphone's camera. Hence, the trainer would not require to attend to each trainee, reducing both effort and time. Figure 1.4.2 shows an example of this practice (Gattullo et. al., 2019).

Another of Augmented Reality (AR) usage is for navigation. This could be attributed to the fact that AR allows for overlaying of virtual element on top of the physical space. Research has shown that AR navigation utilising smartphones yields better navigation results compared to Google Maps and conventional map. Additional information can be added on the smartphone's screen aiding tourist's navigation. For this reason, it is significantly more useful compared to using standard navigation mobile application or maps. Types of navigation information includes distance, direction, and location details (McMahon et. al., 2015). Besides navigation, AR can also be used to better convey information to tourists. Information that would be useful

to tourists includes nearby interesting location, events or even safety information. This additional information viewed through their smartphones would be able to enhance the travelling experience through suggestions of events that are occurring or could take place.

The potential of Augmented Reality (AR) in the tourism industry is significant as can be seen in existing research papers such as ToARist: An Augmented Reality Tourism App created through User-Centred Design by (Williams, Yao & Nurse, 2017), Augmented reality mobile tourism application by Pereira, Abreu and Pinho (2014), Push typed tourist information system based on beacon and augmented reality technologies by Sato, Hirakawa and Shibata (2017) and Mobile tourism application using augmented reality by Safitri et. al. (2017). Being able to implement one of the nine pillars of the 4th IR allows for the tourism sector to benefit from it and further allows the country and the tourists visiting to reap the benefits. According to Williams, Yao and Nurse (2017), with the smartphone becoming more easily obtained and supports the AR technology, head-mounted displays is no longer necessary, making it a viable choice for tourists for navigation purposes instead of paper maps. Another case of AR mobile application being viable is by (Safitri et. al., 2017), where an AR mobile application call Explorasia is developed aiming to improve the tourism industry in Indonesia. According to the feedback received by the 50 students involved, 80 % agrees that Explorasia would achieve the goal of improving tourism in Indonesia (Safitri et. al., 2017). Similarly, if AR is properly implemented in Malaysia's tourism industry, economic growth could be experienced more.

1.4 Impact of Covid-19 Pandemic on Malaysian Tourism Industry

In early 2020, the Covid-19 pandemic posed a significant threat to the Malaysian tourism industry. There was a massive drop of tourists especially from Singapore and China due to the travel restrictions imposed to curb the spread of the virus. Hence, this has caused the Malaysian tourism industry to suffer massive losses forthe hotel and service industry. For example, a total of 170,084 hotel room bookings was cancelled during the period 11 January 2020 until 16 March 2020, which caused a loss of revenue amounting to 68 million Ringgit (Bhuiyan et. al., 2013) .

In 2022, The Tourism Recovery Plan 2022 was introduced by the Malaysian government, which aims to boost the domestic tourism. The plan offers various discount via voucher, discount, or rebate redemption for niche tourism related products. Throughout the entire campaign, a total of 238,908 vouchers have been redeemed by Malaysians. Tourism Malaysia has also partnered with KLIA Ekspres and Kereta Api Tanah Melayu bhd (KTMB) to provide fare discounts.

In March of 2022, the Malaysian government allowed the border open to international tourists to help the tourism industry's recovery. This decision was made after taking into consideration that Malaysia has one of the highest vaccination rates in the world. Additionally, both the hotel and service industry was suffering major losses from further lockdowns. As part of the recovery phase for the tourism sector, hotels and various tourists destinations have begun imposing strict standard operating procedures to ensure both their employees and tourist's safety. Another initiative the Malaysian government takes is the Vaccinated Travel Lane (VTL), which facilitates two-way travel for individuals that have received their completed vaccination. This was done in collaboration with other ASEAN countries such as Singapore, Brunei and Indonesia which had assisted the tourism sector to recover slowly. As part of this

recovery, tourist based technology can be intergrated to provide directions to tourists to avoid congested areas.

1.5 Problem Statement

There are three main issues that this research aims to solve via AR, these issues are tourist navigation, tourism marketing and tourism safety. All these encompases the common issues faced by the tourism industry around the world. Solving these issues allows for better overall tourist's experience.

1.5.1 Tourist Navigation

The mode of navigation for most tourists varies between different countries and cities. Different modes of navigation for tourists includes public transport such as trains, buses, taxis or even just by walking. Walking is a common option among tourists due to the chance of being able to interact with the environment (Nakatani et. al., 2013). However, current navigation features via mobile application has certain disadvantages for tourists. Google Maps has a 2D birds 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 be troubling at times (McMahon et. al., 2015). 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 residential streets (Tools, S., & Giachetti, 2014). 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 by walking. As there are many narrow streets

in the area, tourists could 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 for cars instead of on-foot travelling (Nakatani et. al., 2010). In Yogyakarta, Indonesia, most tourist attractions in the city center are within walking distance where tourists can experience urban street tourism by walking. However, if the tourists wish to navigate Yogyakarta streets by themselves, this proves to be difficult, as the city has an incredibly dense population (Dahles & Bras, 1999). Another example is in Kuala Lumpur, Malaysia where the mode of navigation for tourists is by walking (Mansouri & Ujang, 2016). 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.

1.5.2 Tourism Marketing

The second issue in the tourism industry is in the marketing aspect. Tourism marketing is an important factor in deciding the success of the tourism industry of a country. Globally, there are various medium 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 medias, brochures and more (Rradmin, 2019). 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 (Uzama, 2009). In Singapore, the tourism board realizes that traditional marketing methods such as billboards, flyers and newspaper print ads is slowly becoming ineffective. Hence, the focus would shift to digital marketing as the number of internet and smartphone savvy

users increases (Singapore Tourism Board, 2016). These examples show the importance of digital marketing, which includes mediums such as the social media and websites. However, the tourism marketing in Kuala Lumpur, Malaysia is lacking in digital marketing and is more focused on conventional medias such as the television (DBKL, 2019).

In Kuala Lumpur, the current DBKL marketing strategies includes airline marketing, advertisements on media, etc (DBKL, 2019). These are conventional methods of marketing. When referring advertisement on media, these include the television, streaming websites and such. However, while travelling around, it is unlikely that tourists would have time to watch television or access streaming websites. Even if tourists can access and view tourism advertisement, it 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 (Hernández-Méndez, J., & Muñoz-Leiva, 2015). This would also involve additional task of cleaning up once the banners and flyer is past the event's date. Moving towards the 4th IR, marketing methods should not be limited to only traditional media such as television or radio.

1.5.3 Tourism Safety

Tourism is considered a fragile industry as there are many discouraging factors involved. For example, lack of safety assurance or widespread crime is a discouraging factor. Safety is a critical issue in the tourism industry in many countries including Malaysia. Absence of crime is essential for the tourism sector. Crimes related to tourism are usually highly publicised. This could cause doubt among tourists regarding safety when visiting a country (C.-H. Tan et al., 2017). In 2014, Kuala Lumpur was

the second most state with crime cases occurring after Selangor. Kuala Lumpur is also one of the most visited cities in Malaysia by tourists, hence tourist's safety is of the highest priority (Anuar, N. B., & Yap, B. W., 2019).

Natural or manmade disaster such as earthquake, landslide, flash flood, etc is common in many large cities across the globe. India is one of the countries that has actively discussed the utilisation of Android-based mobile application to notify users regarding impending disasters (Bhattacharjee et. al., 2017). As Android smartphones are cost effective and widely utilised throughout India, it becomes the motivation of this research. On the other hand, Japan has researchers working on ways to rapidly convey emergency message of disaster to the public. The researchers propose rapid conveying of disaster information, they argued that conventional means information conveying is too dispersed, with different medias such as TV and radio has different information source. Instead, they suggested that a unified server is used, where all the disaster information would be originating (Sato, Hirakawa, & Shibata, 2017).

Another research in Japan suggests the usage of Augmented Reality (AR) in smartphones to convey disaster information to international tourists to create awareness and educate (Sakaguchi, Izumi, & Nakatani, 2013). This is done by conveying disaster information to the tourists when they reach a point of interest. When the smartphone is held up, the mobile application would utilise the camera and AR to overlay the disaster information and photos to educate the tourists regarding disasters that has occurred previously in the area on the smartphone's display.

Natural disasters are uncommon in Malaysia; hence the focus in this research is on crime hotspots. Currently in Malaysia, Tourism Malaysia launched a mobile app called 'My Tourist Assist' (MyTA). MyTA aims to ensure safe travels for tourists in Malaysia. Features of MyTA include an emergency or SOS button that will connect

the user directly to the authorities. Tourists would 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 hospital, pharmacies, police, automated teller machines (ATM) and embassy locations. In addition to that, 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).

Hence, there are three main problems with the current Malaysian tourism industry status that would be explored in this research. The first is the lack of proper navigation tool for walking tourists which could hamper their travelling experience in Malaysia in general, and Kuala Lumpur specifically. Secondly, the current marketing methods of DBKL is 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 that Malaysia is still lacking in terms of notifying the tourists, since tourists' safety is of utmost priority of any host country.

1.6 Research Questions

1. What is the current Augmented Reality utilisation within Malaysia tourism from the context of 4th IR?

The current Augmented Reality utilisation must be identified. This is essential as it must be identified whether Augmented Reality is currently widely accepted within the Malaysian government agencies. This also allows the identification of whether the target users are comfortable utilising Augmented Reality for various business

purposes. These purposes include navigation utilising smartphone, disaster notifications, tourism marketing and such. There is a lack of study regarding Augmented Reality utilisation in Malaysia government agencies. Proper guidance must be prepared to ensure users are properly educated or training regarding Augmented Reality utilisation. If the Augmented Reality is not implemented properly from the start, it will not generate the required interest in using Augmented Reality.

2. What are the essential criteria for Augmented Reality implementation in Malaysian tourism sector?

To be implemented in Malaysian government agencies, the criteria of Augmented Reality must be properly analysed. The criteria include the hardware and software requirements, additionally proper software and hardware configuration should also be identified. Example of Augmented Reality hardware are smartphones, virtual glasses, etc, while examples of software are mobile or non-mobile application that supports Augmented Reality. Another essential criterion is how easy for the Augmented Reality system to be implemented. Globally, Augmented Reality has proven be viable in many fields and agencies, such as manufacturing training, tourism and entertainment. However, currently there are insufficient amount of research papers and information on the implementation of Augmented Reality in Malaysian government agencies.

3. How can Augmented Reality be applied effectively within the Malaysian tourism?

The two focus groups for this research are the Malaysian Tourism Agency and the tourists. With these two focus groups in mind, the effective approach in ensuring users are comfortable in utilising Augmented Reality should be identified. The benefits of Augmented Reality towards these two focus groups should first be identified. For the government tourism agencies such as DBKL, proper reasoning and explanation should be given on why Augmented Reality is the right approach towards tourism. These reasonings includes the overall benefit towards the Malaysian Tourism Industry's growth and how does this method attract tourist. Proper approaches should be identified to enable proper implementation of Augmented Reality.

1.7 Research Objectives

1. To properly utilise Augmented Reality in the tourism industry while adhering to the 4th IR.

As previously mentioned, Augmented Reality is one of the nine main pillars of 4th IR. However, figuring the right 4th IR's pillar to be implemented in the tourism is insufficient. Augmented Reality is only a core part of the step required to bring the tourism industry toward, additional requirements must be met such as utilising a Cyber Physical System.

2. To identify the essential criteria for Augmented Reality implementation in the tourism government agencies.

Essential criteria of Augmented Reality must be identified, and the characteristics must fit within the operations of the tourism government agencies. This includes the system

configurations, system hardware, system software, and training of the staff. The cost of implementation is another concern that should be addressed, this is also true for the time required for implementation.

3. To propose and evaluate approaches in applying Augmented Reality in Malaysian tourism industry.

Proper approach should be identified to ensure the target users are able to. Current tourism strategy should also be identified, this is to ensure the new implementation could improve the tourism industry instead of causing it to decline.

1.8 Significance of Study

This research aims to introduce the utilisation of the 4th IR technologies into the Malaysian tourism industry. By introducing the utilisation of the 4th IR technology, Malaysian tourism can be improved. Globally, there are already a number of research conducted that proves the viability of the 4th IR technologies in the tourism industry (Kourouthanassis et.al., 2015; Safitri et. al., 2017), however, that is not the case for Malaysia. In short, currently there is insufficient information on the utilisation of the 4th IR technology in the Malaysian tourism sector. The research aims to fill that gap by proving the viability of the 4th IR in the Malaysia tourism sector. The viability of AR would be proven through the prototype developed for this research.

1.9 Thesis Organisation

Chapter 1 of the thesis titled introduction is sectioned into 6 different sections which are introduction, problem statement, research questions, research objectives, significance of study and thesis organisation. Under introduction, there are 4 different

subsections which are, a brief history of the Industrial Revolution, the 4th IR, the 4th IR in tourism sector and the role of Augmented Reality in tourism sector.

Chapter 2 of this thesis proposal consists of 7 subsections, which are Introduction, Historical Overview of Industrial Revolution, Global Overview of the 4th IR, The 4th IR in Malaysia, The 4th IR in the Tourism Industry, Disadvantages of Augmented Reality and 4th IR in Tourism Industry. The final chapter of the proposal, Chapter 3 is titled Research Methodology. This chapter includes information on the type of research methods that is utilised to conduct the research. The chapter contains 5 sections which are Introduction, Phases of Research Methodology, Data Collection Methods, Data Analysis and Research Outcome.

Chapter 3 titled Methodology which discusses the research methodologies used for the research, consists of 3 subsections: Introduction, Research Design or Phases and Protoype Technical Specification. Under subsection 3.3 Protoype Technical Specification, there are a total of 6 subsections, which are Prototype System Design Overview, Prototype Mobile Application Specification, Prototype Web Application Specification, Maps API Specification, Prototype Server Specification and My-ARt Navigation Handling.

Chapter 4 consists of the data collection results and consists of 5 subsections which are the Introduction, Initial Prototype, Interview Results, Final Protoype Rating and Interview Coding.

Chapter 5 discusses the results collected in Chapter 4 and consists of 9 subsections: Themes and Subthemes, My-ARt's UI Improvements. My-ARt's Crime Hotspot, Importance of My-ARt's Maketing Feature, Importance of My-ARt's Navigation Feature, Importance of My-ARt's Marketing Feature, My-ARt's AR

Navigation Improvement Suggestion, My-ARt's Marketing Improvement Suggestion and My-ARt's Crime Hotspot Improvement Suggestion.

The final chapter of the thesis is Chapter 6: Result Discussion, Conclusion and Future Work, and it consists of 3 subsections: Overview, Conclusion and Research Limitation and Future Work Recommendation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The following literature review would discuss the brief history of industrial revolutions, ranging from the First Revolution to the current 4th IR. The 4th IR is then discussed in-depth as well which includes the core technologies that powers it, the progress of the 4th IR and the global impact of the 4th IR since its introduction by the German government. Under the core technology of the 4th IR, the focus would be on the Augmented Reality (AR) and its usage in different industries around the world. Lastly, the current adoption of AR in the context of the 4th IR, research that has been done to utilise AR's capabilities, and its future potential. Finally, this literature review explores the 4th IR utilisation in the tourism market globally and in Malaysia. The section also includes research that involve the utilisation of AR in the tourism industry, both globally and in Malaysia.

2.2 Historical Overview of 4th IR

According to Li, Hou and Wu (2017), the world has experienced three major technological advances. The three major technological advances are the First, Second and Third Industrial Revolution. The First Industrial Revolution occurred back in Great Britain from 1760 to 1830 (Crafts, 1996). Based on the findings by Australia's Prime Minister Industry 4.0 Taskforce (2017), the textile industries in Great Britain were the heart of the First Industrial Revolution, before the occurrence of the First Industrial Revolution, manual labor and cottage industries was a norm. When the First Industrial Revolution occurred, it brought upon the technology of steam machines and hydraulics (Li, Hou & Wu, 2017). The First Industrial Revolution is important as it paved the way

for the future technological advances and other Industrial Revolutions that comes after it.

In the second half of the 19th century, the Second Industrial Revolution first occurred in the United States (Australia's Prime Minister Industry 4.0 Taskforce, 2017; Ślusarczyk, 2018), and it worked on the foundation laid by the First Industrial Revolution, with the focus instead shifted towards mass production for affordable consumer products. Instead of steam energy, the Second Industrial Revolution utilises chemical energy and electricity (Li, Hou & Wu, 2017). In addition to that, A range of technologies in the industry and mechanization was also developed, such as an assembly line with automated operation (Ślusarczyk, 2018). Though not the first, Henry Ford was recognized as one of the pioneers in utilising the assembly line (Australia's Prime Minister Industry 4.0 Taskforce, 2017).

In the late 1960's, the Third Industrial Revolution occurred (Ślusarczyk, 2018), this is when manufacturing automation, electrical and information technology became a norm (Li, Hou & Wu, 2017). Advances in computers and electronics allow the usage of programmable logic control systems, increasing production quality and efficiency (Ślusarczyk, 2018). According to Rifkin (2008), the Third Industrial Revolution also consists of three renewable energy pillars, the first pillar is the renewable energy itself such as the wind, tidal and solar energy, the second pillar is the ways renewable energy is stored and transported, and the third energy pillar is the smart intergrid, where energy can be produced and shared by homes-owner and businesses.

In the age of the 4th IR, where it is distinct from the previous three industrial revolutions and is characterised by widespread application of Cyber Physical Systems (CPS) in the manufacturing environment (Liu and Xu, 2017). The 4th IR is composed of nine core technologies, which are Autonomous Robots, Big Data Analytics, Cloud

Computing, Internet of Things (IoT), Additive Manufacturing (3D Printing), System Integration, Cybersecurity, Augmented Reality and Simulation (MITI, 2019). The main aim of the 4th IR is to bring the physical and virtual world close based on Cyber-Physical System (CPS) (Australia's Prime Minister Industry 4.0 Taskforce, 2017). More information on the 4th IR will be discussed and focused on subsection 2.4.

Figure 2.2.1 shows the summary of all the Industrial Revolution where it is plotted as period of occurrence against the degree of complexity under each phase of the industrial revolution (Australia's Prime Minister Industry 4.0 Taskforce, 2017). Based on the figure, the First Industrial Revolution or Industry 1.0 occurred from 1760 to 1830 in Great Britain (Crafts, 1996). During this period, the first mechanical weaving loom was introduced in 1784. Since the textile industry is important in Great Britain (Australia's Prime Minister Industry 4.0 Taskforce, 2017), this mechanical weaving loom was a breakthrough along with the introduction of mechanical production facilities with the help of water and steam power. Along with the Second Industrial Revolution or Industry 2.0, the first assembly line was introduced in 1870. Mass production was also made possible with the usage of electrical energy. The Third Industrial Revolution or Industry 3.0 occurred at the beginning of 1970, where the first programmable logic control system was introduced. The focus of the Third Industrial Revolution was to automate production through the usage of IT and the application of electronics. Today marks the period of the 4th IR or Industry 4.0, where the merging of virtual and physical world is the aim. This is done based on utilising the Cyber Physical Systems (CPS).

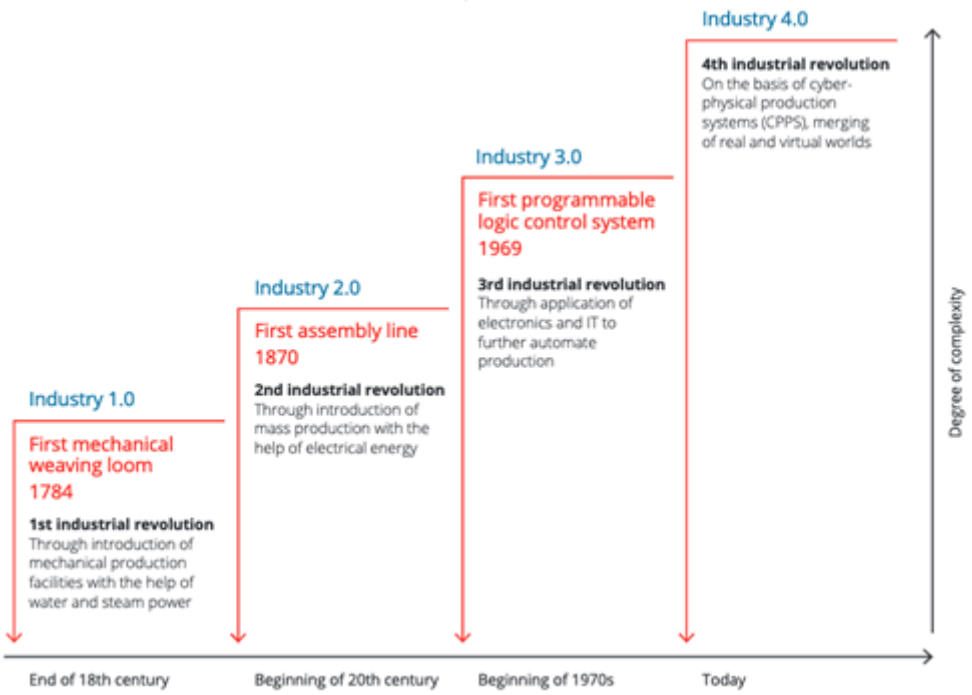

Figure 2.1 Shows the stages of the Industrial Revolution

2.3 Global Overview of 4th IR

The 4th IR, also known as Industry 4.0 was a concept introduced during the Hannover Trade Fair by Germany in 2011 (Jazdi, 2014). Later in 2013, the German Government released the Recommendations for Implementing the Strategic Initiative Industry 4.0. Following this action, the whole world was impacted with the reveal of the 4th IR, opening new possibilities (Li, Hou & Wu, 2017). The 4th IR is an overarching industrial transformation that includes every aspect of industries and economic activities, while the Industry 4.0 is referred to as the digitalisation transformation of the manufacturing and production industries (MITI, 2019). In other words, The 4th IR is manifested in all aspects of the society, including technology, production, consumption, and business, and it is influencing every field of human life.

On the other hand, Industry 4.0 focuses on the production manufacturing sectors (Li, Hou & Wu, 2017). According to Li, Hou and Wu (2017), there are also misconception that the term 4th IR is understood as the Cyber Physical System (CPS).

However, rightfully, the CPS is only as part of the 4th IR. The 4th IR is an overarching industrial transformation (MITI, 2019), while the CPS are automated systems that allows networking of operations between the physical reality to the computing and communication infrastructure (Jazdi, 2014). Traditional embedded systems are stand-alone devices, while CPS focuses on networking of several devices (Guo et. al., 2017).

The 4th IR consists of several core technologies that acts as the foundation such as Big Data Analytics, Cloud Computing, Internet of Things (IoT), Additive Manufacturing (3D Printing), System Integration, Cybersecurity and Augmented Reality (Rüßmann et. al., 2015; MITI, 2019). Autonomous Robots are utilised in many different industries but are mainly known for their usage in modern manufacturing. The focus for autonomous robots is to complete tasks intelligently, with a focus on safety, flexibility, versatility, and collaboration (Bahrin Othman, Azli & Talib, 2016). Big Data analytics is another core technology in the 4th IR, with IT storage capacity becomes cheaper by the day, storage, and analysis of large amounts of data becomes viable. Big Data analytics is useful in various disciplines such as sales predictions, production planning or user-relationship mining and clustering (Niesen, Houy, Fettke & Loos, 2016).

Cloud Computing refers to both the application delivered to users via the internet and the hardware and software in the data center that delivers the application (Fox, Katz, Konwinski & Lee, 2009). In the context of the 4th IR, Cloud Computing can be used to power smart manufacturing, where machine and autonomous robots can communicate with each other using sensors, actuators and other parts via the network governed by a centralized server (Thames & Schaefer, 2016). The fourth core technology of the 4th IR is Internet of Things (IoT). IoT is basically a things-connected network, where things are wirelessly connected via smart sensors (Li, Xu & Zhao,

2014). IoT currently has been developed in fields such as healthcare, transportation, and automotive industries. The fifth core technology of the 4th IR is the Additive Manufacturing.

According to (Wong & Hernandez, 2012), Additive Manufacturing or 3D printing is a process where informations is taken from computer aided design (CAD) file then converted to stereolithography (STL) file. Stereolithography is the process of 3D printing, application of Additive Manufacturing includes the aerospace industry where manufacturing of lighter structure is essential. System Integration, which is the sixth core technology of the 4th IR refers to pieces of software and hardware working and communicating in unison. Businesses that utilises system integration allows them to achieve maximum value (LCR 4.0, 2019). Cybersecurity is another core technology that is of focus in the 4th IR. According to (Von Solms & Van Niekerk, 2013), Cybersecurity is defined as a collection of tools, policies, security concepts, security safeguards, guidelines, risk management approaches, actions, training, best practices, assurance, and technologies that can be used to protect the cyber environment and organization and user's assets. In a paper that discusses the implementation of Cybersecurity in critical infrastructure by (Ten, Manimaran & Liu, 2010), Cybersecurity is important due to the growing number of cyber-attacks in recent years, cyber-attacks are also common because information security adopting an open system architecture.

The eighth core technology in the 4th IR is Augmented Reality (AR), which is the focus of this research. AR's main function to provide a way to access and manipulate information, enhancing the perception of the real world with virtual information layered on top (Esengün & İnce, 2018). More information on AR would be explored in subsection 2.4. The final and ninth core technology of the 4th IR is Simulation.

Simulation modelling is an important method where models can be used to simulate real or imagined system to predict and better understand the behaviour of the system. This is also true for predicting processes and understanding the behaviour (Rodič, 2017). These core technologies should be utilised to fully realise the potential and benefit from the 4th IR.

Globally, the 4th IR or Industry 4.0 has progressed differently in different countries. Over the last few years, manufacturing countries such as Germany, the United Kingdom, Korea, France, and India have been developing technologies in different fields to attain Smart Manufacturing in the industrial arena (Mohamad et. al, 2018). The first column of table 2.3.1 shows the ranking of the top countries in relation to their manufacturing prowess in 2016, while the second column shows the projected ranking of each country in 2020. China tops the list, followed by the United States and Japan in the top 3 position. Some of these countries is expected to improve their ranking by 2020, such as United States, Mexico, India and Malaysia. These top 20 countries also adopted their own national policy to embrace the 4th IR (Liao et. al., 2018).

Table 2.1 List of Countries and Manufacturing Prowess Ranking

Country/Region	**Rank in 2016**	**Projected Rank in 2020**
China	1	2
United States	2	1
Germany	3	3
Japan	4	4
South Korea	5	6
United Kingdom	6	8
Taiwan	7	9
Mexico	8	7

Canada	9	10
Singapore	10	11
India	11	5
Sweden	13	18
Malaysia	17	13
Netherlands	20	21
France	22	26
Spain	25	27
Italy	28	30

According to the Boston Consulting Group (BCG), the United Kingdom will be able to improve their sustainable productivity by 5 to 8 % if the 4th IR is embraced (Cordes & Stacey, 2017). In addition to that, BCG has also conducted an anonymous survey on managers of industrial companies, where 312, 315, 322, 322, and 258 of them are from Germany, United States, France, United Kingdom and China. The results were that 79% of them believes that United Kingdom is progressing towards Industry 4.0, 70% of them says that the United Kingdom has reached the Industry 4.0 goals last year (2016), 70% of the answer pointed that United Kingdom are prepared for the skill changes and 71% of them believes that the United Kingdom is ready for Industry 4.0 technologies (Cordes & Stacey, 2017).

The German government considers “Industrie 4.0” as the ultimate step towards establishing smart industrial units and blend of projects encompassing the government, private sector, and academia (Mohamad et. al, 2018). In Germany, industry is driven mainly by family owned small and medium sized enterprises (SMEs). In addition to that, lean manufacturing is also a focus for SMEs in Germany, where productivity is