MOBILE AUGMENTED REALITY TOURISM APPLICATION FRAMEWORK

RASHIDI BIN ABD RASHID

A dissertation submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Information Technology

Faculty of Computing
Universiti Teknologi Malaysia

January 2017

The temptation to quit will be greatest just before you are about to succeed.

This research is dedicated to my family especially to my mother, Jamilah
Bte Mohd Lip and my father, Abd Rashid Bin Mohd Amin.

ACKNOWLEDGEMENT

First and foremost, I would like to thank Allah for the most beneficent and most merciful for giving me good health and strength to be able to pursue my studies in master degree level. It is my intention to continue my studies and thanks to Allah for giving me permission to achieve that. I am grateful for what I have especially my family. They fully agree and supported me all the way. I would not be here without them. I would like to dedicate this research and its success to my dearest family who has helped and supported me in my studies. Despite all the challenges that I have faced, I cherish and enjoy my time studying and learning new things especially in Universiti Teknologi Malaysia (UTM). Thank you to UTM for giving me the opportunities to continue my studies.

I would also like to convey my warmest and wholeheartedly appreciation to my supervisor, Dr Halina Mohamed Dahlan who have guided me throughout my studies. Her guidance and knowledge allow me to refine my skill in research and writing. She also helped me in publishing my research findings for the benefits of others. Her help, her motivation, her belief in me allow me to finish my studies.

ABSTRACT

One of the field that in fast growing is the tourism industry. Developing mobile tourism application requires a thorough study on requirements. This research discussed the conception, inception and implementation of the framework for mobile augmented reality tourism application. Thus, the objective of this study to analyse and construct requirement needed for a mobile augmented reality tourism application framework and to apply the framework in product development. The framework consists of requirements pyramid model and components of the user, technical and system design requirements which are dependent on each other. The framework adopts user-centered design approach by refining user input in user requirements all the way to product development. The questionnaire is distributed to 105 respondent to find out whether the software requirement component proposed are according to their needs and expectation. Descriptive and factor analysis were used to analyse the data. Based on the result, the component proposed have a high-reliability index, indicating that the components are acceptable. The findings provide a foundation into constructing mobile augmented reality tourism application framework and facilitate the software development. This research hopes to contribute to the field of software requirements and able to give guidance to other researchers who are interested in the field of mobile augmented reality tourism application.

ABSTRAK

Salah satu bidang yang berkembang pesat adalah industri pelancongan. Membangunkan aplikasi pelancongan mudah alih memerlukan satu kajian menyeluruh mengenai keperluan perisian. Kajian ini membincangkan konsep, permulaan dan pelaksanaan rangka kerja untuk aplikasi pelancongan mudah alih menggunakan realiti berperantara. Oleh itu, objektif kajian ini untuk menganalisis dan membina keperluan perisian yang diperlukan untuk rangka kerja aplikasi pelancongan mudah alih menggunakan realiti berperantara dan membangunkan produk perisian menggunakan rangka kerja tersebut. Rangka kerja ini terdiri daripada keperluan perisian model piramid dan komponen penting dalam keperluan pengguna, teknikal dan sistem yang bergantung antara satu sama lain. Rangka kerja ini menggunakan reka bentuk berpusatkan pengguna dengan mengambil kira input dari pengguna sehingga terhasilnya produk perisian. Soal selidik diedarkan kepada 105 responden untuk mengetahui sama ada keperluan komponen perisian yang dicadangkan mengikuti keperluan dan jangkaan pengguna. Analisis deskriptif dan analisis faktor telah digunakan untuk menganalisis data terkumpul. Berdasarkan kepada keputusan, komponen yang dicadangkan mempunyai indeks kebolehpercayaan yang tinggi, menunjukkan bahawa komponen yang dicadangkan boleh diterima pakai. Penemuan dari hasil kajian ini akan menyediakan asas untuk rangka kerja aplikasi pelancongan mudah alih realiti berperantara dan membantu dalam membangunkan produk perisian. Kajian ini berharap dapat menyumbang kepada bidang keperluan perisian dan dapat memberi panduan kepada penyelidik lain yang berminat dalam bidang aplikasi pelancongan mudah alih realiti berperantara.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ABBREVIATION	DESCRIPTION
API	Application Programming Interface
AR	Augmented Reality
ASEAN	Association of Southeast Asia Nation
DSR	Design Science Research
GDP	Gross Domestic Product
ICT	Information Communication Technology
IDE	Integrated Development Environment
IT	Information Technology
MCMC	Malaysian Communication and Multimedia Commission
MTB	Malaysia Tourism Board
MVC	Model-View-Controller
MVP	Model-View-Presenter
NKEA	National Key Economic Area
PCA	Principal Component Analysis
POI	Point of Interest
UNWTO	United Nation World Tourism Organization
UTeM	Universiti Teknikal Malaysia Melaka
UTM	Universiti Teknologi Malaysia
VR	Virtual Reality

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1.   Research Overview

Trends in tourism right now keep on increasing with tourist flood countries such as Malaysia in 2015 reaching to 25.7 million tourist and total spending reaching out to roughly 69 billion receipts with average spending is at RM 2,687 per person (Tourism Malaysia 2015). This statistics shows that there are a market in tourism that keeps on growing and if technology support tourism process, it will make tourism more efficient and tourist able to enrich their travel experiences.

Tourist like to be informed about certain interesting places or things to do especially in one-time events that they might miss out on (Brown 2007). This also allows local people to helps tourist by making suggestion and recommendation for them to include in their activities. This sharing activity enabled by technology, enrich tourist experience when travelling (Hanrahan & Krahenbuhl 2012).

There are many technologies that support tourism process. Such technology is the use of Internet and web to communicate and recommend a point of interest (POI) shared from one tourist to another. The evolution of web technologies allows two-way communication between service provider and user (Aghaei et al. 2012). User able to provide some form of feedback and service provider to offer conveniences service to

its user. Resultant content able to benefit both parties. This technology not only benefited the web but also have been seen benefited the mobile space as well.

With the advancement in technology such as mobile device, it's a matter of time before smartphone become one of the enablers of tourism activities. The nature of smartphone allow it to be mobile, this makes it suitable for tourism activities as tourist travel from place to place (Hanrahan & Krahenbuhl 2012). Added that with the ability of a smartphone to install a mobile application that able to provide benefit to its user, makes it a convenient way to be used in tourism activities.

A third-party application utilising location-based service, connection to the internet and crowd-sourcing information from the masses unlocks a wide range of possibility that future application can offer. The application installed in user smartphone able to support tourism activities easily such as a recommender system, mobile travel guide, information portal, navigation, waypoint, virtual map, and digital guidebook (Yovcheva et al. 2012). Moreover, such application can be combined with virtualization to provide an attractive factor in mobile application especially in today world where virtualization is getting attention.

Augmented reality (AR) technology is one of the forms of virtualization technique where the information is added to the field of view of the user. Usually to extend or enrich their experience exploring the world. Information can be arranged in a way that is attractive and comprehensive to the user, using a graphic to show relevant information in a compact space. AR application can be conveniently installed on a user's smartphone and can be combined with tourism application to provide features (Han et al. 2013).

In order for mobile tourism application to appeal to the masses, software requirements are needed to capture the needs and expectation of the user. User requirement can be collected and then transform to the technical requirement to lay the foundation for the system design process that is needed to develop the application.

Software requirement is important to create a product that is dedicated to cater to user needs on all stages of the design process and development lifecycle (Wiegers & Beatty 2013).

Software requirements research in mobile AR application context is not properly highlighted as compared to another computing field such as web and desktop application. Hence, this research comprehensively studied the literature on software requirements, analyse requirement needed to construct mobile AR tourism application framework, and develop mobile AR tourism application based on the proposed development framework.

1.2.   Background of the Problem

The traditional way of tourist travelling is by using pamphlet of city map or travel guidebooks to navigate through the city. This type of method is favourable with an elderly person and research found out they have a good experience when using it in their travelling activities (Hanrahan & Krahenbuhl 2012). The explanation for this gave by Brown (2007), guidebooks are designed in a structure and standardised manner, filled with information about attraction, accommodation, and point of interest including contact details and opening hours. Tourist like to be informed and get a recommendation so that they can plan their travelling activities ahead of time especially to unfamiliar places. This is due to the fact that tourist hates surprises and uncertainty on the place they about to visit (Brown 2007). Guidebook gives a glimpse of what to expect on the recommended places, so this pique the interest of tourist to follow suits the recommended activities given by the guidebook. Having a guidebook becomes a more practical approach as it calms and gives a sense of safety to tourist during travelling.

The only problem with these type of guidebooks is that the book is rarely updated with its contents. For example, some of the best shop or tourist destination

have been close or move to other places. It will take a long time for the guidebook to update its contents. Even by one-year update cycle, it is nearly not enough to keep content updated. By the time the contents are updated more changes are required after that and it quickly becomes obsolete once again. Brown (2007) added that additional information and description on interesting places are needed in a guidebook as currently it is insufficient and can lead to confusion.

Using web technology seem to handle all of the problems with the conventional way of travelling by using a guidebook. Content can be added or remove instantaneously without a hassle. The user can get an update on the latest news and information regarding their travel places. Added that to the evolution of web technology enable user and service provider to share responsibility in providing content. The user can push or pull data to the web and allow other user benefit from their shared information. The problem is that user needs to request the data beforehand to be able to get the information needed. Unlike mobile application where the information can be delivered to user's device directly without the need to request to the server. In addition to that, the nature of web technology is often access by using desktop or laptop which are not fully mobile. This creates inconveniences to the user especially in tourist activities where they need to bring their information anywhere.

An application that is installed in the smartphone has more benefit than using a plain web browser. The advantage of using an application as compared to the browser is that application can push message directly to the user personal smartphone devices. This type of notification called "push message" notification allow the server to push timely information directly to the user, rather than the user request such information called "pull message" (Burgstahler et al., 2014; Warren et al., 2014). The user wants their information to serve directly in front of them rather than them trying to search for the said information. The effectiveness of push technology can be increased by using personalised and geared toward the needs and interest of each individual user. This can be done by using contextual information such as user's location, time, and activities to predict and sent timely information directly to them so that tourist will not miss on interesting events or places. As a result, a more memorable tourist experience can be

achieved using user's personalization by the means of a mobile application (Warren et al. 2014).

Fast-paced and abundance of the smartphone device makes AR become a viable option to be implemented to the smartphone device. This is due to the fact that device nowadays is getting more powerful, cheaper and more functionality (Malik 2012). Malik also claims that smartphone will have an impact on our daily lives as it's quickly become the norm when almost two billion people will have a smartphone in their possession by 2016. This gives huge potential to develop an AR application to be used on a small pocket device such as a smartphone.

This study will focus to develop a mobile AR tourism application that can solve the various problems discussed earlier. A problem such as outdated contents can be solved by the using software and internet connection to push a timely update to the users. Website owner or content creator can update regular contents instantaneously to the web by using the internet and user can receive them without missing any new information. The location-based and context-aware application can be utilised to send timely notification or recommendation on various interesting things or events to the user. In addition to that, user profiling can give insight on what are the needs, expectation and interest of the user so that the recommendation reflect the interest of the user. Developing such application require a proper software requirements analysis. Software requirements are needed so that the application can achieve it intended purpose and objective.

This study will also propose software requirement that is suitable to be implemented in an AR mobile tourism application context. Software requirement is created as a way to describe purpose and intents of solving the problems (Wiegers & Beatty 2013). Requirements also contain condition or criteria that need to be met in order to satisfy the specification of the end product produced. This is done so software development phase that comes later can access some form of control and monitor the progress of the product to be in line with the proposed software requirements. Thus, translating the product to match the planned objective of what it is intended to be.

1.3. Problem Statement

The main question in this research is **"How to construct a framework that will help in the development of mobile AR tourism application?"** Besides developing the mobile application as the centre point of this research, the following question also needs to be solved:

1. What are the requirements needed to develop a mobile AR tourism application?
2. How to construct a framework for mobile AR tourism application?
3. How to develop mobile AR tourism application based on the proposed framework?

Based on the above statement, this research will use AR technology as its backbone and apply it in mobile tourism application. A study to find the requirements necessary for the development of mobile AR tourism application is needed so that the requirement to develop the prototype can be proposed to other interested researchers. Thus, the objectives of this research are defined in the next section.

1.4. Research Objectives

The main objectives of this research are to embed AR technology into tourism by the means of an application installed in mobile devices such as a smartphone. In order to actualize the research objectives, there is another subcomponent that is needed to be achieved which are:

1. To analyse the requirements needed for mobile AR tourism application.
2. To construct a framework for mobile AR tourism application.
3. To develop the prototype of mobile AR tourism application based on the proposed framework.

1.5.   Scope of the Study

The research aim is on integrating augmented reality with a mobile application in tourism domain. The application will be installed on top of smartphone devices that is expected be able to execute the application task. The detailed scope of this research are as follows:

1. Explore the software requirements necessary to be developed in mobile AR tourism application based on existing literature.
2. Choose the suitable requirements to be proposed for the development of mobile AR tourism application framework.
3. Based on the proposed framework, a prototype will be developed in mobile AR tourism application.

1.6.   Significance of the Study

The innovation in technology opens up a new area waiting to be discovered. AR is one of the technologies that is still in its infant but has a good prospect in the near future. It is only normal that when a new technology arises, people will try and experiment new things with it, AR is no exception. Currently, there are a lot of people experimenting with the technology in the different area, such area is in a tourism sector. Thus, this research tries to contribute to tourism context by developing mobile AR tourism application. The application can provide user on interactive graphic and information without blocking them of their surroundings.

Showing the capabilities of new technology by building on top of an everyday device ease the penetration rate of the application to reach more user. It can also promote more and more developer to take the leap to experiment and build more interesting and functional application using AR, not necessarily in the same tourism sector.

This application can take advantage of the ever increasing demand of tourism. With more and more tourist flooded the country, it is better to offer such application that they can use to gain information and knowledge of the place they are visiting. Tourist or traveller that are expected to be the main user of this application can use it to their advantage especially in enriching their travel experience either by presenting interesting and relevant information to them or ease their tourist activities. The mobile application can be used as a mobile travelling companion for tourist.

This study constructs mobile AR tourism application framework based on existing literature. The framework is intended to be a guide for other researchers or developer to use it in developing mobile AR tourism application. They can also adopt the framework in their own context or field. The contribution of this study hopes to shed some light in software requirement such as user, functional or non-functional and gained the interest of other researchers in this field as well.

1.7. Organization of Thesis

This chapter discusses the overview of this study which divided into a different section. The introduction section explained the general concept of tourism demand, the evolution of the web and mobile space, and tourist point of view, analysing software requirements, construct mobile AR tourism application framework. Then, discussion the nature of the problem that resulted in the development of the mobile application based on the proposed framework.

There are three main objectives of this research that are needed to be achieved which are to analyse the requirements needed for mobile AR tourism application. Next, to select the best requirements to construct a framework for mobile AR tourism application. Lastly, to develop the prototype of mobile AR tourism application based on the proposed framework. This chapter ends with the explanation on significant of the study and how it can contribute to society.

REFERENCES

Aghaei, S., Nematbakhsh, M.A. & Farsani., H.K., 2012. Evolution of the world wide web: From WEB 1.0 TO WEB 4.0. *International Journal of Web & Semantic Technology (IJWesT)*, 3(1).

Ajanki, A., Billinghurst, M., Gamper, H., Järvenpää, T., et al., 2011. An augmented reality interface to contextual information. *Virtual Reality*, 15(2–3), pp.161–173.

Anon, 2010. Overview of the National Key Economic Areas. Available at: http://etp.pemandu.gov.my/Sectors_in_Focus-@-Overview_of_NKEAs.aspx [Accessed March 21, 2016].

ASEAN, 2002. ASEAN TOURISM AGREEMENT - ASEAN | ONE VISION ONE IDENTITY ONE COMMUNITY. Available at: http://www.asean.org/?static_post=asean-tourism-agreement [Accessed April 10, 2016].

Azuma, R.T., 1997. A survey of augmented reality. *Presence: Teleoperators and Virtual Environments*, 6(4), pp.355–385.

Barnes-Hoggett, P., 2011. Quality software —12 non functional requirements every app should have. , p.1. Available at: http://eyefodder.com/2011/06/quality-software-non-functional-requirements.html [Accessed November 9, 2016].

Bhuiyan, M.A.H., Siwar, C., Ismail, S.M., Islam, R., et al., 2011. Potentials of Islamic Tourism: A Case Study of Malaysia on East Coast Economic Region. *Australian Journal of Basic and Applied Sciences*, 5(6), pp.1333–1340.

Brito, C. de la N.A., 2015. Augmented reality applied in tourism mobile applications. In *2nd International Conference on eDemocracy and eGovernment (ICEDEG)*.

IEEE, pp. 120–125.

Brown, B., 2007. Working the problems of Tourism. *Annals of Tourism Research*, 34(2), pp.364–383.

Buhalis, D., 2003. eTourism: Information Technologies for Strategic Tourism Management. In *International Journal of Tourism Research*. pp. 456–466.

Buhalis, D. & Jun, S., 2011. E-tourism. *Contemporary tourism reviews*, pp.1–38.

Burgstahler, D., Richerzhagen, N., Englert, F., Hans, R., et al., 2014. Switching Push and Pull: An Energy Efficient Notification Approach. In *2014 IEEE International Conference on Mobile Services*. IEEE, pp. 68–75.

Butler, G., Khoo-Lattimore, C. & Mura, P., 2012. Heritage Tourism in Malaysia: Fostering a Collective National Identity in an Ethnically Diverse Country. *Asia Pacific Journal of Tourism Research*, 19(2), pp.199–218.

Castillo-Manzano, J.I., López-Valpuesta, L. & González-Laxe, F., 2011. The effects of the LCC boom on the urban tourism fabric: The viewpoint of tourism managers. *Tourism Management*, 32(5), pp.1085–1095.

El Choubassi, M., Nestares, O., Wu, Y., Kozintsev, I., et al., 2009. An augmented reality tourist guide on your mobile devices. In *Lecture Notes in Computer Science*. pp. 588–602.

Chung, N., Han, H. & Joun, Y., 2015. Tourists' intention to visit destination: Role of augmented reality applications for heritage site. *Computers in Human Behavior*, 50, pp.588–599.

Dieck, T., Claudia, M. & Jung, T., 2015. A theoretical model of mobile augmented reality acceptance in urban heritage tourism. *Current Issues in Tourism*, pp.1–21.

EMarketer, 2011. 2 Billion Consumers Worldwide to Get Smart(phones) by 2016. Available at: http://www.emarketer.com/Article/2-Billion-Consumers-Worldwide-Smartphones-by-2016/1011694 [Accessed April 12, 2016].

Grigolon, A.B., Kemperman, A.D.A.M. & Timmermans, H.J.P., 2012. The influence of low-fare airlines on vacation choices of students: Results of a stated portfolio

choice experiment. *Tourism Management*, 33(5), pp.1174–1184.

Han, D.-I., Jung, T. & Gibson, A., 2013. Dublin AR: implementing augmented reality in tourism. In Z. Xiang & I. Tussyadiah, eds. *Information and Communication Technologies in Tourism 2014*. Cham: Springer International Publishing, pp. 511–523.

Hanrahan, J. & Krahenbuhl, P.D., 2012. An Assessment of Tourist Demand and Use for Travel Guides: A Focus on the Use of New Technology Such As Smartphones and Downloadable 'Apps. *I.T. Sligo*. Available at: http://www.failteireland.ie/Research-Insights/Papers-Reports/Assessment-of-Tourist-Use-of-Travel-Guides-and-Sma.aspx?feed=be21cc58-5303-42d9-a001-36bb20d5a177 [Accessed March 30, 2016].

Hoffmann, A., 2010. Pattern: requirement pyramid. In *Proceedings of the 15th European Conference on Pattern Languages of Programs - EuroPLoP '10*. New York, New York, USA: ACM Press, p. 1.

Homayounvala, E. & Pourmehr, N., 2015. Evaluation of Augmented Reality Technology Acceptance By Iranian Tourists. *International Journal of Information Technology and Business Management*, 42(2304–777), pp.25–30.

Hui, L., Hung, F.Y., Chien, Y.L., Tsai, W.T., et al., 2014. Mobile Augmented Reality of Tourism-Yilan Hot Spring. *Ubi-Media Computing and Workshops (UMEDIA), 2014 7th International Conference on*, pp.209–214.

Al Jahwari, D.S., Sirakaya-Turk, E. & Altintas, V., 2016. Evaluating communication competency of tour guides using a modified importance-performance analysis (MIPA). *International Journal of Contemporary Hospitality Management*, 28(1), pp.195–218.

Jung, T., Chung, N. & Leue, M.C., 2015. The determinants of recommendations to use augmented reality technologies: The case of a Korean theme park. *Tourism Management*, 49, pp.75–86.

Jung, T. & Han, D., 2014. Augmented Reality (AR) in Urban Heritage Tourism. *e-Review of Tourism Research*.

Kabassi, K., 2010. Personalizing recommendations for tourists. *Telematics and*

Informatics, 27(1), pp.51–66.

Kaufmann, H., 2003. Collaborative augmented reality in education. *Keynote Speech at Imagina Conference*, pp.1–4.

Kosnan, S., Ismail, N. & Kaliappan, S., 2013. Determinants of international tourism in Malaysia: evidence from gravity model. *Jurnal Ekonomi Malaysia*.

Kounavis, C.D., Kasimati, A.E. & Zamani, E.D., 2012. Enhancing the tourism experience through mobile augmented reality: Challenges and prospects. *International Journal of Engineering Business Management*, 4(1), pp.1–6.

Ku, E.C.S. & Chen, C.D., 2015. Cultivating travellers' revisit intention to e-tourism service: the moderating effect of website interactivity. *Behaviour & Information Technology*, 34(March), pp.465–478.

Kysela, J. & Štorková, P., 2015. Using Augmented Reality as a Medium for Teaching History and Tourism. *Procedia - Social and Behavioral Sciences*, 174, pp.926–931.

Leffingwell, D. & Widrig, D., 2003. Managing Software Requirements: A Use Case Approach.

Malik, M.Y., 2012. Power Consumption Analysis of a Modern Smartphone. *arXiv preprint arXiv:1212.1896*, p.11.

Markov, G.A., Hoffmann, A. & Creighton, O., 2011. Requirements Engineering Process Improvement: An Industrial Case Study. In *Requirements Engineering: Foundation for Software Quality: 17th International Working Conference, REFSQ 2011*. Essen, Germany: Springer, pp. 34–47.

May, K., 2010. Malaysia Airlines dabbles in mobile augmented reality with deals and directions. Available at: https://www.tnooz.com/article/malaysia-airlines-dabbles-in-mobile-augmented-reality-with-deals-and-directions/.

MCMC, 2015. Hand Phone Users Survey 2014. *Malaysian Communications and Multimedia Commission*. Available at: http://www.skmm.gov.my/Resources/Statistics/Hand-phone-Surveys/Hand-Phone-Users-Survey-2014.aspx [Accessed April 12, 2016].

Milgram, P., Takemura, H., Utsumi, A. & Kishino, F., 1994. Augmented Reality: A class of displays on the reality-virtuality continuum. *SPIE (International Society of Optics and Photonics)*, 2351(Telemanipulator and Telepresence Technologies), pp.282–292.

Misrahi, T., 2014. Smart Travel: Unlocking Economic Growth and Development through Travel Facilitation | World Economic Forum. *29 September*. Available at: https://www.weforum.org/reports/smart-travel-unlocking-economic-growth-and-development-through-travel-facilitation.

Mohamad, M., Ali, A.M., Ghani, N.I.A., Abdullah, A.R., et al., 2012. Positioning Malaysia as a Tourist Destination Based on Destination Loyalty. *Asian Social Science*, 9(1), pp.286–292.

Muzaini, H., 2006. BACKPACKING SOUTHEAST ASIA. *Annals of Tourism Research*, 33(1), pp.144–161.

Neto, J. de O. & Martins, V., 2008. Non Functional Requeriment to Voice User Interface on Interactive Television. An initial Study. *IADIS International Conference ...*, pp.77–84.

Olsson, T. & Salo, M., 2011. Online user survey on current mobile augmented reality applications. In *2011 10th IEEE International Symposium on Mixed and Augmented Reality*. IEEE, pp. 75–84.

Pospischil, G., Umlauft, M. & Michlmayr, E., 2002. Designing LoL@, a Mobile Tourist Guide for UMTS. In *Human Computer Interaction with Mobile Devices: Proceedings of the 4th International Symposium, Mobile HCI 2002 Pisa, Italy, September 18–20, 2002*. pp. 140–154.

Rajasekar, S., Philominathan, P. & Chinnathambi, V., 2006. Research Methodology. *arXiv preprint physics/0601009*, p.23.

Rasinger, J., Fuchs, M., Beer, T. & Höpken, W., 2009. Building a mobile tourist guide based on tourists' on-site information needs. *Tourism Analysis*, 14(4), pp.483–502.

Shafiee, S. & Shafiee, H., 2014. Studying the effective factors on domestic tourists trust in offering e-services in e-tourism: Case study Iran Country. In *e-*

Commerce in Developing Countries: With Focus on e-Trust (ECDC), 2014 8th International Conference. IEEE, pp. 1–9.

Statista, 2015. Smartphone users worldwide 2014-2019 | Statistic. Available at: http://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/ [Accessed April 12, 2016].

TNS, 2014. TNS Global market research company. Available at: http://www.tnsglobal.com/ [Accessed April 13, 2016].

Tourism Malaysia, 2015. Tourism Malaysia | Statistic 2015. Available at: http://www.tourism.gov.my/statistics [Accessed April 27, 2016].

UNWTO, 2014. Over 1.1 billion tourists travelled abroad in 2014 | World Tourism Organization UNWTO. *UNWTO*. Available at: http://media.unwto.org/press-release/2015-01-27/over-11-billion-tourists-travelled-abroad-2014 [Accessed April 10, 2016].

UNWTO, 2015. Why tourism? | World Tourism Organization UNWTO. *UNWTO*. Available at: http://www2.unwto.org/content/why-tourism [Accessed March 21, 2016].

Vaishnavi, V. & Kuechler, B., 2004. Design Science Research in Information Systems Overview of Design Science Research. *Ais*, p.45.

Walek, B. & Klimes, C., 2012. Fuzzy tool for conceptual modeling under uncertainty. In Z. Zeng & Y. Li, eds. *Fourth International Conference on Machine Vision (ICMV 11)*. International Society for Optics and Photonics.

Warren, I., Meads, A., Srirama, S., Weerasinghe, T., et al., 2014. Push Notification Mechanisms for Pervasive Smartphone Applications. *IEEE Pervasive Computing*, 13(2), pp.61–71.

Wiegers, K., 2003. *Software Requirements*, Microsoft Press.

Wiegers, K. & Beatty, J., 2013. *Software Requirements*, Pearson Education.

Wong, E.P.Y., Mistilis, N. & Dwyer, L., 2010. Understanding ASEAN tourism collaboration - the preconditions and policy framework formulation. *International Journal of Tourism Research*, 12(3), pp.291–302.

Wrenn, E., 2012. Google Glass augmented-reality specs available NOW for $1,500 | Daily Mail Online. Available at: http://www.dailymail.co.uk/sciencetech/article-2165818/Google-Glass-augmented-reality-specs-available-NOW-1-500.html [Accessed March 23, 2016].

Wyner, A. & Schneider, J., 2012. Arguing from a Point of View. *AT*, pp.153–167.

Yovcheva, Z., Buhalis, D. & Gatzidis, C., 2012. Overview of smartphone augmented reality applications for tourism. *e-Review of Tourism Research*, 10(2), pp.63–66.

Yuen, S., Yaoyuneyong, G. & Johnson, E., 2011. Augmented Reality: An Overview and Five Directions for AR in Education. *Journal of Educational*. Available at: http://yuen.us/blog/?p=2504 [Accessed March 20, 2016].

Zhou, F., Dun, H.B.L. & Billinghurst, M., 2008. Trends in augmented reality tracking, interaction and display: A review of ten years of ISMAR. *Proceedings - 7th IEEE International Symposium on Mixed and Augmented Reality 2008, ISMAR 2008*, pp.193–202.