Smart Tourism Architectural Model

(Kingdom of Saudi Arabia: A Case Study)

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***Abstract*—The researchers have proposed and implemented a general application architecture model that complies with the demands of the Saudi tourism sector to be used by tourists on their mobile devices. The design architecture aims to improve tourism sector opportunities, facilitate tourists' guidance in the holy and historical places, fill in the shortage of having multilingual tourists' guides, cut off cost expenses and build up capacities. It can support KSA to be a tourist attraction in the region. The research project employs the usage of the Quick Response (QR) codes and the Information Communication Technology (ICT) which are capable of converting the smart phones into a tourist guide device. This new system can be considered as a Smart Cicerone (S-Cicerone). The research project has a flexible design that allows tourists, guests and administrators to interact easily with the system in order to use its services and perform a regular system update and management. The system design is based on component-based architecture including Tourist Layer services, Smart Tourism System Layer services and the Administration Layer services. The components are divided into further services and smartly integrated to formulate the main application functions. This project is meant to be implemented in the Kingdom of Saudi Arabia as a pilot project and is also valid for implantation in any other countries.**

Keywords*—Smart tourism; smart systems; QR-Code; Saudi tourism; Saudi Vision 2030; S-Cicerone

I. Introduction

Smart systems facilitate daily life activities by using sophisticated appliances which integrate and function seamlessly with minimal human intervention [1]. Smart systems may employ the touching technology "Smart Touch Technology STT" for functionality. However, smart systems are defined to be the integration of technologies and services through networking for a better quality of living standards [2]. The term Smart has been added to different applications to indicate smartness in such systems. For instance, smart cities imply the use of smart system technologies to achieve resource optimization, effective and fair governance, sustainability and quality of life. Smart tourism, smart home, smart factory, smart traffic, smart card, smart TV and so on are examples of employing the term smartness in the real world for the beneficiary of the end user [3].

Smart tourism is a modern expression that implies the use of emerging forms of Information and Communications Technologies ICT with the tourism industry and which allows the exchange of massive data for better tourism services [4]. The term Smart describes economic and social developments armed with technology that utilizes sensors, hardware, software, embedded systems, big data and special connectivity (i.e. Internet of Things (IoT), Radio Frequency Identification (RFID), Quick Response (QR) code, and Near Field Communication (NFC)).

The Kingdom of Saudi Arabia "KSA" has launched its future vision "Saudi Vision 2030" which covers many sectors including tourism. In the tourism sector, the vision states that "we will enrich pilgrims' spiritual journeys and cultural experiences widely in KSA. We will establish more museums, prepare new tourist and historical sites and cultural venues, and improve the pilgrimage experience within the Kingdom." [5]. By 2025, the tourism industry is expected to create over 930,000 jobs [6] which means that tourism in KSA is very promising and needs more capital and technology investments which are mainly the high concern of the public and private sectors. The Saudi Commission for Tourism and National Heritage published its road map for the Saudi tourism for the years 2002-2020. The commission stated that currently the Saudi tourism sector relies on the cheap labor of people from South East Asia to cover the tourism sector jobs. The commission has launched a training program "Ya Hala" to train 1.5 million Saudi people in the tourism sector. This rehabilitation program includes many tracks such as the tourism guide, learning languages and many other tracks.

II. Technology in Tourism

A. Facts and Tools

Tourism is considered as one of the largest industries worldwide. It generates about 11% of the global gross domestic product (GDP), employing more than 200 million employees worldwide, and serving more 700 million tourists each year [7]. Recently, the adoption of ICT has changed the traditional viewpoint of tourism from conventional towards electronic tourism (e-tourism). Using smartphones-based services to provide smart tourism might be called smart tourism instead of e-tourism. Different technologies have been adopted to support using technology in tourism. For instance, Internet of Things (IoT), Radio Frequency Identification (RFID), Quick Response (QR) code, Near Field Communication (NFC) are examples of such technologies. In this work, the researchers have chosen the QR-code for implementation.

Sponsored by the Deanship of Scientific Research; Northern Border University, Arar, **K.S.A**.

B. Quick Response (QR) Code Technology

A Quick Response (QR) code is a type of barcode that can save information about certain object. The amount of information is much more than the traditional bar codes. This technology is accessible for any smartphone equipped with a camera, a QR code reader/decoder and a network connection. The QR codes are widely used in video streaming, online menus, advertising campaigns, linking to websites, and signing up to pages [8]. QR Codes have a well-constructed error correction scheme that allows recovery of damaged codes up to 30% of the damage [9]. The QR code orientation is usually managed and adjusted automatically by the QR code reader [10]. The only limitation on reading the code is the reading distance.

Some facts should be already known about the QR codes. It is worth mentioning that these facts call for either mandatory or optional requirements. Some researchers mentioned the basic facts and QR code requirements as listed below [11]:

1) A QR Code is 2D Barcode.

2) QR code can store a variety of data (Typically: 7,089 numeric characters without spaces or 2,953 alphanumeric characters with spaces and punctuation).

3) Most smartphones can scan QR codes for Reading/Decoding purposes.

4) QR code can be placed in nearly any location.

5) There are some other types of QR codes (Data-Matrix code, Google tags, PDF417 and AZTEC) [12].

6) To run a QR code you need the following:

a) QR code generator (website service)

b) QR code reader (mobile application)

c) Optional QR code management/tracking tool (website service)

d) Generators: Different generators have varying features. Choosing a generator is based on the options for:

i. Code Format (i.e. QR, EZcode, Tag, etc.)
ii. Stored Data (i.e. hyperlink, meCard, SMS, etc.)
iii. Output (i.e. color, size, download file type, etc.)

7) Management tools are available to track scanning analytics.

8) QR code content should provide special value for the customer.

9) Small or complex QR codes can't be scanned by smartphones with lesser quality cameras.

*10)*Testing scan ability factors are:

a) Smartphone cameras (resolution/auto-focus)

b) Reader apps

c) Scanning context (i.e. lighting, shadows, surfaces)

d) Scanning distance

e) Scanning timing

f) Scanning angle

g) Scanning in different environment conditions.

III. Related Works

Some governments in Europe like Australia and Asia (i.e. China and South Korea) have started to support smart tourism infrastructure. The governments' interests differ from region to region but all of them care about end-user applications that enrich tourism experiences [3].

Different tourism institutions from different countries over the world have conducted research work and implemented tourism applications in different forms. In the research [7] Smart Travel Guide: Application for Android Mobile, the researchers have proposed using android-based application to provide timely information for tourists and tourism institutions whenever it is needed. Mash-up technologies along with web-based applications have been used to collect and manipulate the requested information like the weather and the tourist's current geographical location, map, and distance between cities. The Smart Travel Guide has the choice to retrieve the required information either as text, picture or video formats.

In the work of [3], the researcher introduced an overview of the smart tourism concept. Koo identified smart destinations, smart business ecosystems and smart experiences as the three basic components supported by layers of data creation, processing and exchange. He also defined using technology in tourism as an infrastructure rather than individual information system and focused on the traveler as the user of the system. The system aims to support travelers by three services. First, it suggests user's needs and interests like dining and accommodation. Second, it enhances travelers' experience by offering information, location-based services, maps, inquiries and interactive services. Third, it shares travelers' experiences. The research work has distinguished between e-tourism and smart tourism, not only in the technologies it employs but also in the approaches that make use of tourist experience and feedback.

In the work presented by [13], they discussed the problems that face the tourists in their travels. The collaborative nature of tourists is used to design implications on how we could build better tourist technology. Tourists usually work together in groups, negotiate and arrange their activities according to their schedule. The system allows tourists to collaborate, share and exchange their experiences and activities. It also aims to help tourists gain experience and plan their visits beforehand by means of shared practices such as maps that show the current 'social structure' of the city. The system has expanded and become part of the City project; it has developed tourist best activities to support cooperation between local and remote museum visitors and has explored media in city life.

Juho Pesonen and Eric Horster [14] expected the NFC to be one of the tremendous technological progress in the coming few years especially in the travel and tourism sectors. They also presented the several NFC implementations and possibilities. NFC offers tourism many useful tools and applications. Juho and Eric reviewed earlier researches in NFC technology and investigated the current state of NFC technology usage in tourism companies. They considered the several critical issues that affect the commercial success of the NFC mobile service. These issues are stated as the slow adoption of NFC mobile-based services, unclear revenue that

are attractive to end users and the fact that there is no business model to handle diverse interests and possible conflicts. A generalized approach for NFC application development is being developed which is the inclusion of the Mobile Network Operators and Service Provider in this model. Smart posters as advertisements is another usage of the NFC where the user can hover the phone over the NFC tag located on the poster and have a URL transferred to the smartphone. Then the user can easily follow the link. Benyó, on the other hand, presented NFC-based application that is capable of handling a smart shopping cart system for retail stores. This system eliminates the need to stand in line in order to pay. Another implementation is the indoor navigation system that is called NFC Internal. Spreading the NFC tags over a building enables easy data to transfer for indoor navigation just by touching the tags. Utilizing social media is another possibility of using NFC applications. For example, Hot in the City is an NFC application that allows users to make friends by touching other users' NFC devices through the peer-to-peer mode. [15]

IV. Proposed Solution

The Smart Tourism System (STS) is a funded research project that attempts to support the Saudi vision 2030 on the context of improving the tourism sector opportunities. STS aims to help the Saudi tourism authorities to facilitate marketing and managing the tourists' activities in the holy ancient and historical places while keeping tourists' privacy safe. The project also aims to fill in the shortage of having multilingual tourists' guides, cut off cost expenses, build capacities and hence prepare KSA to be a tourist attraction in the region. It thrusts the country to switch up from the traditional models of monolingual to multilingual approach.

The STS research project employs the usage of the QR codes technologies to facilitate access to the information of the historical and ancient places in KSA. Once the QR code is scanned, the project will:

1) Convert the smartphone to operate as a smart well-trained multilingual tour guide with a professional guiding experience.

2) Show pictures of the place along with its history.

3) Display a proposed guided tour walk through the site.

4) Operate on behalf of the tourism help desk in the sense that it can demonstrate how to start and end the tour timely and manageably.

5) Maintain tourist privacy and give the tourist the opportunity to move freely anywhere and anytime without being confined with the tourist schedule.

The following sub sections explain the proposed solution in more details.

A. STS Assumptions

The researchers assume the following:

1) Tourists are aware of the existence of the Smart Tourism System STS application in the site location.

2) Tourists have already uploaded the STS application from Google/Apple store.

3) Tourists' smartphone is ready for mobile data and/or Wi-Fi connection.

4) Tourists' data plan and credit allow access to the STS services (The ministry of tourism might provide Wi-Fi access, either free or paid, that covers the whole site).

5) Tourists are aware of using and utilizing QR codes.

6) The QR codes are easy accessible, cannot be tampered with and clearly shown to tourists.

7) The QR codes are large enough to be scanned from distance. The relationship between scan distance and minimum QR code size is approximately 10:1. So a 2.5^{cm} QR code requires an effective scan distance of about 25^{cm}, and a 50^{cm} QR code size requires an effective scan distance of about 5^{meters} [16].

B. STS Constraints

The research constraints are out-of the control of the project and can limit the design alternatives. The following summarize some of these constraints [17]:

1) Mobile data connection speed might not support the required audio/video streaming speed.

2) The research project will only cover Arar ancient mosque, as the first phase (pilot project). After that the researchers will cover some other historical ancient sites before launching the final project countrywide.

3) The NFC tag phase will be implemented on the second phase of the project.

4) Implementing the project might face resistance from some tourists' guides since the project might threaten their careers.

5) Using Google maps will be limited to the allowed Google terms and conditions of free access (i.e. 2500 free request per day). In case of requested charge fees for any Google map service, that service will not be supported.

C. STS Component Services

Fig. 1 shows the main system components services including Tourist Layer services, STS Layer services and the Administration Layer services. These layers are integrated together to generate the main system services. The three layers services are logically divided and categorized according to the type of the offered service.

The Tourist layer services are intended to provide tourists with registration and authentication and allow tourists to share their experience and provide feedback. However, the STS layer services generate location-based and content delivery services. The type of content delivery depends on the type of the user whether he/she is a registered or a guest user [18]. The Administration layer service mainly concerns about the administration control services and the database management and tuning services.

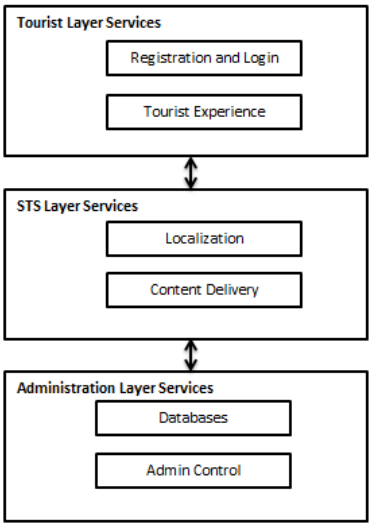

Fig. 1. STS component services.

The separation between the three different layers is a logical separation rather than a physical one and it is for control purposes only. This separation makes the STS services more manageable.

D. STS Workflow

This section presents the working flow of the mobile tourist guide system. Firstly, we assume that tourists have already registered with the system and provided their personal information. Afterwards the system services can be categorized as shown in Service architecture[19]:

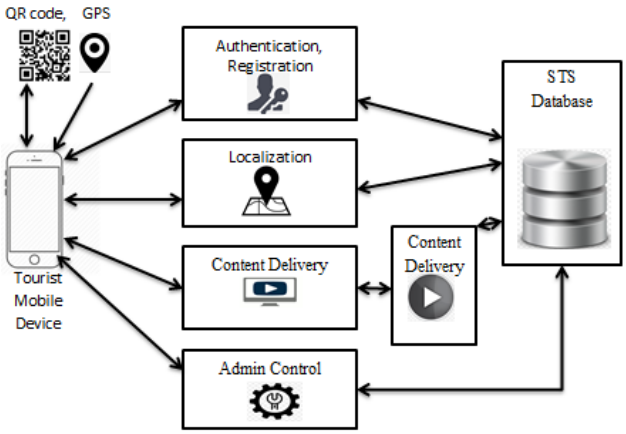

Fig. 2. Service architecture.

The algorithm shows the basic STS services. These services can be listed in the following steps:

1) Initialization step: It prepares the STS application to operate; it turns on the available internet connection (i.e. Wi-Fi or mobile data) and the QR code reader, GPS services and the STS application.

2) Registration step: It aims to encourage tourists to register their basic information in the STS database. In this sense, the registration process builds a communication channel between tourists and the tourism agencies to enrich the tourist experience and add more future customer services depending on tourists' notes and feedback. The services offered to the registered tourist are not restricted; they can enjoy the full STS system services like listening to audio, watching video, reading textual data and providing feedback. In case of those users who are not registered, the system will ask the user to register.

3) Check the tourist type step: The STS have three types of users: Guest user, Registered user, and Admin user.

The users' functions and services are:

1) The Guest user is allowed to access only the limited STS services so that to encourage different tourist to register, share their experience and provide feedback about their tour in order to enhance the STS services based on the tourist feedback.

2) The Registered user can use the full STS system services and provide feedback.

3) The Administrator user can control the system, add, modify, delete STS data, generate reports, calculate statistics and perform system maintenance. In short, the administrator can monitor the system performance and control the access to the system. The STS can provide the administrator with different types of reporting like number of played videos, the peak time of playing videos, most frequent videos usages and so on.

4) Reset credentials: Registered tourists can reset their passwords and change their basic personal information.

E. STS Architecture

System architecture is composed of different system components to support the system functionality. The grouping components methodology is very common when building mobile applications. The application designer usually takes into consideration grouping the components into areas of concerns and focuses based on interaction between the different components and how those components work together [20].

Fig. 3 shows the architecture and design. The STS application is a piece of code that is designed to be installed on the tourist mobile phone. It contains the main tourist services like scanning the QR/NFC tags, choosing the language preference, defining location, mapping the nearest place to visit and providing tourist feedback. The Localization contains the location and tagging services. The location service is connected to the Global Positioning System GPS which provides the users' current and nearby locations. Moreover, the Wi-Fi/Mobile data connectivity is provided here to facilitate the Internet access. The Tagging services are the QR-code or NFC tag that are posted on a specific location and they contain the link address to access the required information either by watching the video streaming or getting the textual information about the desired location [21]. The Processing Center service is responsible for answering the users' queries and providing the required information in a specific format (i.e. video streaming or textual information) and it allows tourists to provide feedback about their experience.

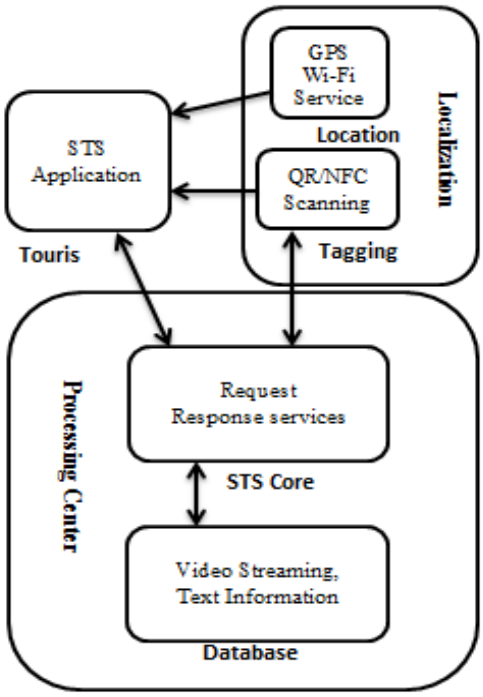

Fig. 3. Architecture and design.

F. Algorithm Description

The STS is designed to operate on Android devices on the first phase. Then it will be expanded to cover other operating systems in later phases of the project, i.e. iOS and Windows Mobile [19].

First of all, the tourist is supposed to install the STS application from the digital distribution platforms for mobile devices (i.e. Google play). The tourist device is supposed to be connected to a Wi-Fi/ Mobile data connection, and for better services, it is recommended to turn-on the GPS services. Once the tourist has installed the STS application, the STS services should be available upon request. The tourist can access the services either as a registered tourist or as a guest. When accessing the services as a registered tourist more services can be offered by the system.

The following algorithm summarizes the general STS services as follows:

Start
Initialize / Internet, GPS and mobile data connection initialization*
/ Camera, QR-Code reader and application initialization*
If new tourist / check for the type of user*
If like to register
Register for service / Not registered user and wants to register*
*Get username /*Assign login ID for future authentication*
Assign password / Set new credentials*
Else
*Login as Guest /*not registered user and want to login as Guest*
End-if
Else
Provide login credentials / Already registered user*
If Valid credentials / provide the user ID and password (Authentication)*
Determine user type (Tourist, Admin)
Else
Enter valid credential / want to reset password or forget password*
Reset credentials
Loop
End-if
End-if
Case user
*Guest user /*Guest Services will be provided*
Get basic services
Get tourist guide in text format / only textual data is provided*
No available feedback services
No available GPS services
Valid authentic Tourist / Full STS services will be provided to a registered user*
Get STS services
Get tourist guide in audio, video and text format
Get feedback services
Get available GPS services
Valid authentic Admin / Administrator services will be provided*
Get STS services
Update STS raw data in different format
Get STS reporting and statistics
Perform system maintenance and tuning
Monitor system performance and tourists' feedback
End-case
End

V. Comparison with Other Systems

None of the related work mentioned above provides the same service as the STS does. For most of the above mentioned works either focus on tourist services like booking accommodation, flights, restaurants and entertainment or help tourists explore or navigate attraction. On the other hand, the STS project aims to convert the smartphone device into a handy smart tourist guide with no extra charges. Table 1 shows a brief comparison of STS with other similar works.

TABLE I. STS COMPARISON WITH OTHER SYSTEMS

Service/ usage or support	STS Smart Tourism System	Smart Tourism via Smart Phone	Travel Guide: Application for Android Mobile
IoT support	Yes	Partially	No
QR-Code usage	Yes	Partially	No
Smartphone based	Yes	Yes	Yes
Web-based support	Yes	Yes	No
Entertainment	No	Yes	Yes
Tours guides	Yes	Yes	Yes
Booking and Reservations	No	Yes	No
Rating and Feedback	Yes	Yes	No
Multi-lingual tourist guides	Yes	No	No
Cloud Computing	No	Yes	No
Location Based Services	Yes	Yes	Yes
Weather Forecast	No	No	Yes
Calculate Distance between Places	Yes	Yes	Yes

VI. CONCLUSION AND FUTURE WORK

The STS system can be a multilingual and a well-trained tour guide system with a professional guiding experience and which is considered as a replacement of a human tourist guide. The STS can show pictures and display a proposed guided tour walk through the site. It can also be a beneficial tool for the tourism help desk in the sense that it can organize the tour smoothly. However, it can also keep the tourists' privacy safe and help the tourist move freely without being confined with the tourist guide schedule.

In the future, many smart services can be added to the system like smart object sensing and recognition, service rating, tourist crowded estimation, hotel booking, ticket buying, restaurant reservation, car renting and many other services. The STS could be implemented in the holy and historical places in the Kingdom of Saudi Arabia as a pilot project and is valid for implantation in any other country.

ACKNOWLEDGMENT

The authors wish to acknowledge the approval and support of this research study by the grant N° SCI-2016-1-6-F-5775 from the Deanship of Scientific Research at Northern Border University, Arar K.S.A.

REFERENCES

[1] Puja Rani, Oshin. Smart Wireless Attendance Monitoring Using NFC , International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol. 3, 2015.

[2] Kim, Rosslin John Robles and Tai-hoon. Applications, Systems and Methods in Smart Home Technology: A Review, International Journal of Advanced Science and Technology, Vol. 15, 2010.

[3] Koo, Ulrike Gretzel & Marianna Sigala & Zheng Xiang & Chulmo, Smart tourism: foundations and developments. Institute of Information Management, University of St. Gallen : Springer, 2015.

[4] Pu Liu, Yuan Liu, Smart Tourism via Smart Phone, International Conference on Communications, Information Management and Network Security (CIMNS 2016), 2016.

[5] Arabia, Kingdom of Saudi. Vision 2030 : Kngdom of Saudi Arabia, 2015.

[6] Saudi Chamber, Jeddah. Tourism in Saudi Arabia. Jeddah : JEDDAH CHAMBER, 2016.

[7] N., Dadape Jinendra R. Jadhav Bhagyashri R. Gaidhani Pranav Y. Vyavahare Seema U. AchaliyaParag. Smart Travel Guide: Application for Android Mobile. International Conference on Recent Trends in Engineering & Technology, Special Issue of International Journal of electronics, Communication & Soft Computing Science & Engineering, 2012.

[8] Canadian Heritage Information Network's (CHIN) Professional Exchange, Museums, The Association of Nova Scotia. QR Code How-To Guide, 2015.

[9] P´eter Bodn´ar, L´aszl´o G. Ny´ul. Improved QR Code Localization Using Boosted Cascade of Weak Classifiers, 2015.

[10] Emek, Mehmet, Usage of QR code in tourism industry.. ethiye, Turkey, 6th World Conference for Graduate Research Tourism, Hospitality and Leisure, 2012.

[11] Schottmuller, Angie. Top 14 Things Marketers Need to Know About QR Codes. Search Engine watch. [Online] 12 30, 2011. [Cited: 2 25, 2017.] https://searchenginewatch.com/sew/how-to/2066777/top-14-things-marketers-need-know-about-qr-codes 2011.

[12] Adrian Dabrowski, Katharina Krombholz, Johanna Ullrich, Edgar R. Weippl. QR Inception: Barcode-in-Barcode Attacks. ACM 978-1-4503-3155-5, 2014, Vol. 14.

[13] B. Brown, M. Chalmers, Tourism and mobile technology. Helsinki, Finland : Kluwer Academic Press, Eighth European Conference on ComputerSupported Cooperative Work 2008.

[14] Juho Pesonen, Eric Horster. Near field communication technology in Tourism. Tourism Management Perspectives, Vol. 4, 2012.

[15] Eric Horster, Juho Pesonen. Tourism Management Perspectives, Vol. 4, 2012.

[16] Chhabra, Neeraj. Comparative Analysis of Different Wireless Technologies. International Journal Of Scientific Research In International Journal Of Scientific Research In Network Security & Communication Network Security & Communication work Security & Communication, Vol. 1, 2013.

[17] Hung-Kuo Chu, Chia-Sheng Chang, Ruen-Rone Lee, Niloy J. Mitra. Halftone QR Codes. Article 217, ACM Transactions on Graphics, Vol. 32, 2013.

[18] S. Alletto, R. Cucchiara, G. Del Fiore, L. Mainetti, V. Mighali, L. Patrono, and G. Serra. An Indoor Location-aware System for an IoT based ,IEEE Advancing Technology for Humanity, 2015.

[19] J.D. Meier, Alex Homer, David Hill, Jason Taylor, Prashant Bansode, Lonnie Wall, Rob Boucher Jr, Akshay Bogawat. Mobile Application Architecture Guide. Microsoft patterns & practices, 2008.

[20] Stephan Böhm, Daniela Ruthardt, Mobile Tagging in German Magazines: A One-Year Study of QR Code Usage in Top-Selling Mass Market Publications, Germany : Scientific & Academic Publishing, Vol. 4, 2014.

[21] Mohit Patil, Rahul Sakore. Smart Parking System Based On Reservation, International Journal of Scientific Engineering and Research (IJSER), Vol. 2, 2014.