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Smart tourism and location-based services architectural model

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ABSTRACT

A one-stop-service for the tourism sector is proposed in this work. To build and develop smart tourism services you need many key tourism stakeholders' participation and integration which is not an easy effort; in this work, we proposed some important tourism basic services like Location-Based services, Location-Aware services, Tourism Information, smart tourism guide, navigation, localization, emergency notifications, and tourist experience. The researchers used the Component-Based-Architecture (CBA) approach that was integrated with a layered service approach to build the smart tourism model. This architecture allows for easy system expansion and adoption.

1. Introduction

Mathematics The fast growth and rapid development in the fields of Information and Communication Technologies (ICT), along with the evolving mobile technologies, has encouraged the development of smart applications in different areas (Antikainen et al., 2006). Most of the current mobile applications have location-aware and location-based capabilities, which become an essential part of our daily life activities (Jinendra et al., 2012). The recent developments in mobile-based services encouraged the public and private sectors to employ this technology to improve services, enhance profitability, reduce cost, and increase customer penetration to information. Usually, people face difficulties when exploring places. They have to ask someone or get help from paper maps, which are usually printed on brochures or leaflets. A smart tourism system that is equipped with location-based services (LBS) is an excellent solution to overcome these difficulties. The technology development led to the appearance of smart systems services, which minimize the human intervention in demand response to interaction with the systems and the applications (Puja-Rani, 2015). Smart systems integrate technologies and services through networking for easy life practices (Robles and Kim, 2010). Also, smart systems have the potential to make many achievements in the tourism sector, particularly in promoting travel planning, suggesting traffic conditions, navigation messages, environment queries, finding the nearest restaurants, finding hotels, tourist guides, and many others (Gretzel et al., 2015).

Travel and tourism sector in 2017 has the power for wealth and employment creation in the global economy; it contributes about 3.8% of the Global Domestic Product (GDP) growth. In total, the Travel and Tourism sector in 2016 generated about US$7.6 trillion (10.2% of global GDP) and 292 million jobs worldwide. The sector accounted for 6.6% of total global exports and almost 30% of total global service exports (WTTC, 2017), and served more than 700 million tourists each year (Jinendra et al., 2012).

Smart tourism differs from e-tourism in the sense of using smartphones-based applications to provide tourism services. Different tourism and tourism-related services get benefits from the technological revolution in ICT, Internet of Things (IoT), Radio Frequency Identification (RFID), Quick Response (QR) code, and Near Field Communication (NFC), Global Positioning System (GPS) and Location-Based Services (LBS) which are commonly abbreviated as "app" (Al-Omari and Al-Marghirani, 2017).

Nowadays, tourism sector adapts the fast-changing technology environment (Gajdošík, 2018); it is a rich environment for mobile application services, where smart tourism can be offered to provide the traveler with the necessary information before, during, and after the travel. As the amount of information and smart services increases, it becomes difficult for travelers to manage and find the right information at the right time (Ricci, 2010).

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Smartphone devices nowadays have the ability to locate users and provide them with the information relevant to their surrounding locations at anytime and anywhere. Currently, each of the major smartphone platform providers has its own mapping solution; MapKit for Apple, Google-Maps for Android, and Here-Maps for Windows Phone. In addition, it is possible to develop a custom made application for equipped smartphone sensors such as Global Positioning Systems (GPS), Accelerometer, and Magnetometer to determine the user's location, altitude, and direction. Smartphones have the ability to employ mapping solutions in different applications (apps/app) such as smart applications, Virtual Reality (VR), or Augmented Reality (AR) (Juleigh et al., 2017).

In this work, we developed a framework model for Location-Based Services in tourism sector. These services have the capability to provide the traveler with right and accurate information at the right time based on the traveler's physical location. The provided information includes the description of sights, landmarks, attractions, tourism spot addresses, photo galleries, and the available facilities. The framework model will use different technologies such as Global Positioning System (GPS), Google Maps, mobile data, wireless connectivity, smartphone capabilities, smart tourism guide system (Al-Omari and Al-Marghirani, 2017) and other technologies.

2. Related works

Nowadays, we live in a personalization and customization era where contextual information has a great influence on our life choices. Users' location plays a major role in real contexts creation. Location-based services are getting more and more relevant to daily human activities. Several systems that serve the tourism sector worldwide exist; most of them are based on offering specific tourist services, which make the travelers' trip more convenient and comfortable. There are two broad categories of tourist systems exist: The Context-Aware-Service (CAS) and the Location-Based-Service (LBS). Most of the existing tourism applications are either web-based or mobile-based applications "apps." The Apps industry has attracted the interest of many researchers, scholars, and software developers. Nowadays, smart tourism Apps are handy tools for supporting tourists with the relevant information during their travels, and these apps have a competitive advantage in promoting travel planning and facilitate providing tourists with suggestions based on their location, preferences, behavior, and history (Lim et al., 2017).

Some other important research works on a non-tourism sector were performed using LBS and CAS. Patil and Sharifshaikh (2015) proposed a mobile app for Android-based phones called City-Lense to overcome the problem that people usually face when they explore cities, they have to ask someone to get directions of the mark places which they want to visit or might search the Internet for such services. City-Lense aims to provide mobile users with personalized services according to their current location. The researchers developed an algorithm to find the shortest path in a graph by moving the phone in the direction that a user wants to go. City-Lense can provide extra services like advising users of current traffic conditions, providing routing information, helping the user to find nearby attractions. Vanjire et al. (2014), in their work, discussed different issues related to providing LBS like the potential provided service and the expected technology and infrastructure constraints. The researchers list some of the promising LBS areas of implementation and they name the LBS components based on the Android platform. The researchers proposed some mobile setting and users' services like profile changing of mobile mode (i.e., from normal mode to silent mode) for certain places, the nearest friend locator, family member finder, helping users to find places of attraction like hospitals, schools, gas stations within a certain range of coverage.

In the research of Jinendra et al. (2012), the researchers used Mash-up web-based application technology to collect information and location. Then the application provides various types of tourist services like LBS, landmarks, attractions, the distance between cities, weather, and videos. Gretzel et al. (2015) considered the basic components of any smart tourism system to be smart destinations, smart business ecosystems, and smart experiences; the smart system should support travelers' suggestions and interests. It should enhance travelers' experience by offering interactive services and shares tourists' experiences. Brown and Chalmers (2003) used the collaborative nature of tourists to design implications on how to collaborate, share, and exchange their experiences and practices.

Hinze and Voisard (2003) proposed a Location-Based Services (LBS) application that is able to provide tourists with timely information that is specific and non-redundant. The proposed systems Tourism Information Provider (TIP) provides tourist mobile device with various types of information based on location, time, the profile of end tourists, and their history.

Simcock et al. (2003) developed a location-based Tourist Guide Application for outdoor users. The application shows buildings in view, attractions, and utilities nearby, such as public cafeterias, hotels public libraries, and others. They describe the Tourist Guide system and its design and usability issues. The application has three modes: Map mode, guide mode, and attraction mode. The map mode provides a map of the site being toured. The guide mode shows a list of available options that can be overplayed on the map (i.e., cafeterias, hotels). The attraction mode supplies the user with sound, images, and textual information that is regularly updated based on the current traveler's location.

Zipf (2002) proposed a model for adaptive map generation that is based on LBS. He introduced the

LBS in two aspects, the spatial and personal context for proactive tips to generate a personalized tourist map. According to Zipf (2002), LBS for tourist services should be realized. It should be personalized in addition to being location-aware service. The realization is achieved using smart behavior and intelligent agents. The spatial context agent can draw the traveler's attention to the near-by objects of interest by showing tourists tips and suggestions. The spatial context agent needs to be aware of the tourist's interests and the location of the near-by objects; this will allow the support of the proactive provisioning tips by showing objects of interests like restaurants, hotels, museums, and other facilities. Some other researchers employed the concept of smart tourism in creating real-time customer-oriented services in the form of big data using data sensors networks and (Zalluhoğlu et al., 2015).

Al-Omari and Al-Marghirani (2017) proposed and implemented a mobile application architectural model that aims to improve tourism business opportunities and offers smart tourists' multilingual guidance guides. The proposed model helps in cost reduction and builds up capacities. The application model benefits from the Quick Response (QR) codes built-in capabilities in most smartphone devices integrate with the Information Communication Technology (ICT) to convert the smartphone device into a smart tourist guide device. The proposed application model is flexible enough to allow tourism institutions and tourists to interact easily with the application. The application model builds on Component-Based Architecture (CBA) (Chaudron et al., 2005), where there are three main layers of service; the Tourist Layer services, Smart Tourism System Layer services, and the Administration Layer services. These layers are subdivided into more sub-layers and are integrated smoothly to provide the required services.

3. The proposed solution

3.1. Research background

This work extends the work performed by Al-Omari and Al-Marghirani (2017) by converting the provided services to smart LBS services. The location-based Service (LBS) is a platform that provides information services based on the users' current location, supported by the smartphone devices, Global Position System (GPS), mobile data connectivity, and digital maps. LBS provides location-specific data that is relevant to individual profile check-in into a place. It provides a practical tool for individuals to track friends and relatives at any particular place and it can remotely monitor business activities. It also could be used for matching tourists' locations with travel preferences and friend recommendations (Attahiru and Lattimore, 2015). The location information can display the geographical position where the mobile device is located. Location based services consist of two Application Programming Interface (API) components, the Location Manager (API Maps) that provides means of maps manipulation and the Location Providers (API Location) that provides location search technology used by the device. The real-time association of GPS and location data with the API Location offers the opportunity to determine the user's location at that time, displacement and proximity to certain locations. This concept is an extension of context-aware Service (CAS) which is another form of LBS that based on performing operations depending on the users' profile or preferences and current location (Kumar et al., 2009).

3.2. Research objectives

The project will use the concept of Context-Aware-Service (CAS) which can enrich tourists' experience and engagement to different tourism activities through employing the basic services of smartphones (Kumar et al., 2009), for instance by using the:

1. Tourist guide service, to replace the tourist guide person with a smart application service that provides tourism guidance service in the multilingual approach.
2. Navigation and tracking service using active digital maps to guide tourists and learn how to recognize directions and help with route optimization for best-reaching destinations.
3. Location services, this service is helpful when the tourist misses his tourist group.
4. Personalization of Information Services, such as queries about the nearest tourism attraction or a facility such as theaters, hotels or travel agents. This service might be extended to filter the information in order to list only those activities that meet certain conditions.
5. Notification service to send emergency and safety notifications, especially in the events of emergency and safety calls.

3.3. Research assumptions and constraints

The proposed system is based on the following assumptions:

1. The application is preinstalled or ready to be installed upon use.
2. An active wireless Internet connection is available with adequate speed (at least 3G internet connection).
3. An active GPS connection is available.
4. The tourism authorities regularly update the tourist information.
5. Tourists use the application interactively and give feedback and ratings.

The system may suffer from some constraints which are outside the control of the project and limit

the design alternatives, these constraints are as follows:

1. Limited or no Internet service is available.
2. Some services might be affected by the misuse of other agencies or institutions.
3. Some services might be limited or not effective due to bad use or ignorance of other users or landmarks.
4. The accuracy navigation or tacking services is affected by the accuracy of the digital maps and the place holders

3.4. System components

The proposed architecture consists of three layers of service; each layer provides different functions and services to each system user where three different types of users have:

1. Registered users: Those users who are already registered with the system and they want to use the system interactively. This type of user will be granted full access to the users' privileges and they can enjoy all the benefits of the system.
2. Guest users: Those users who want to use the system without registering their information, this type of users will be granted limited access to the users' privileges and they can receive emergency notifications and can benefit from the tourists' experience.
3. Administrators: This type of user will be responsible for the technical support, they can generate reports and statistics in addition to system maintenance, troubleshooting, upgrading and keeping track of the system updates.

The layers of services as shown in Fig. 1:

1. App layer: This layer provides the basic services for different types of users, it is called the Tourists services, and the layer consists of the following functional components:

a. QR Scanning: This function needs registration and is used to scan the QR tagging. The QR codes are tagged on selected mark-places to enable the use of smart tourism guide services. This function enables tourists to listen, watch or read the historical information usually presented by tourism guides who accompany tourists during their tour.
b. GPS/ Wi-Fi: This function is freely accessible to all users and it aims to enable the built-in connectivity services and integrate them into the tourism system. This module is intended to facilitate enabling the required connectivity service when it is required, the system should ask the user to grant permission to turn on the required connectivity service like the Mobile Data, GPS, Wi-Fi, NFC, and QR code reader.
c. Navigation: This function needs registration and it represents the heart of the system. It collects the users' current location either from the GPS sensor or from the service provider (SP) and it integrates the location with the rest of the system databases to prepare the requested service like navigation, explore directions, get suggestions, display attractions, display mark-places based on preferences and users experience.
d. Personalization: This function needs registration and it customizes the system according to the tourist's favorites or presetting. Keeping the tourist system favorites like colors, language, displaying order of functions and services as well as remembering the last visited places, dates, expenses, and attractions are important component service that will enhance the overall system services.
e. Notifications: This function is accessible by all types of system users; they can receive emergency notifications from tourism authorities or from the tourism agency. This function can also help tourist groups to send and receive alerts from each other.
f. Tourist experiences: This function is freely accessible by all users and it aims to share tourists' experience and give feedback and rating of the available services at the visited places. This function can help system administrators to improve the system components and it can help tourism authorities to get feedback about the quality of services offered to tourists.

2. Middleware layer: This layer compromises the upper and lower layers of the system; it wraps the requests replies both directions.
3. Content layer: This layer represents the core functions of the system, where the tourists' information, the tourist experience, the geospatial functions, and navigations are stored. This layer consists of two modules:

a. The Service module, and it consists of the following service modules:

i. Multimedia Streaming: This module controls the audio-video streaming requests, and it controls the multilingual requests from different users, it also contains the metadata management of the audio-video contents.
ii. Location Collector: In this module, the exact location of the user is collected, usually it is collected from the GPS connection or from the service provider in either way the latitude and longitude of the user are required. It is recommended to use the Google Location Services APIs, which are part of Google Play Services that provide a powerful, high-level framework that automatically handles location providers, user movement, and location accuracy. The Location manager class provides access to the system location services that obtain periodic updates of the device's current location.
iii. Personalization: This module helps tourists to customize their requests based on different criteria

like (user experience, user profile, the highest suggested areas, user preferences, and requests), the module is connected with most types of databases of the system to provide the basic and advanced user requests, on this module smart algorithms are used to gather the users' information from all other components of the system.

iv. Alerts and Safety Notifications: This module is used by the system administrator or might be connected to the official authorities via smart connection to broadcast safety messages and notifications, also the tourists' groups cloud use this module to notify the tourists' group members of any notifications they want to share.

v. Administration and Maintenance: This module is used by the system administrators to manage the system and grant users access rights, manage users and system updates.

b. The Database module, this module represents the system container, where different databases are maintained:

i. Audio Video: It contains the audio-video file in different languages

ii. Tourism Data: This is the most important part of the system, it is the data repository of the system, it contains all the collected data about the system like tourists' data, landmarks, places, facilities, user profiles, user preferences, users experience, the feedback, rating and the highest suggested places to visit.

iii. GIS Provider: It contains the history of the user places.

iv. Notifications: It contains the notifications of the system and the related information of the notifications like notification type, date, time, purpose, source, priority, and others.

The Tracking services can be implemented by the Location-Determination-Service (LDS), which in turn depends on the support of the smartphone GPS receiver; there are other methods for LDS, which can be used in combining the Cell Phone Towers, Wi-Fi Access Points, the IP address geo-location and the user-defined location. The LDS service is performed by recording a set of coordinates including latitude, longitude, and then calculated to find the altitude (Lazović et al., 2015).

Geographical Information Systems (GIS) is a system that consists of Hardware, Software, and Geographical Data. All are connected through computer networks. The GIS software provides functions and utilities to manipulate geographical information, and it has specialized tools for querying, analyzing, image viewing, data mapping, and reports generating (Lazović et al., 2015).

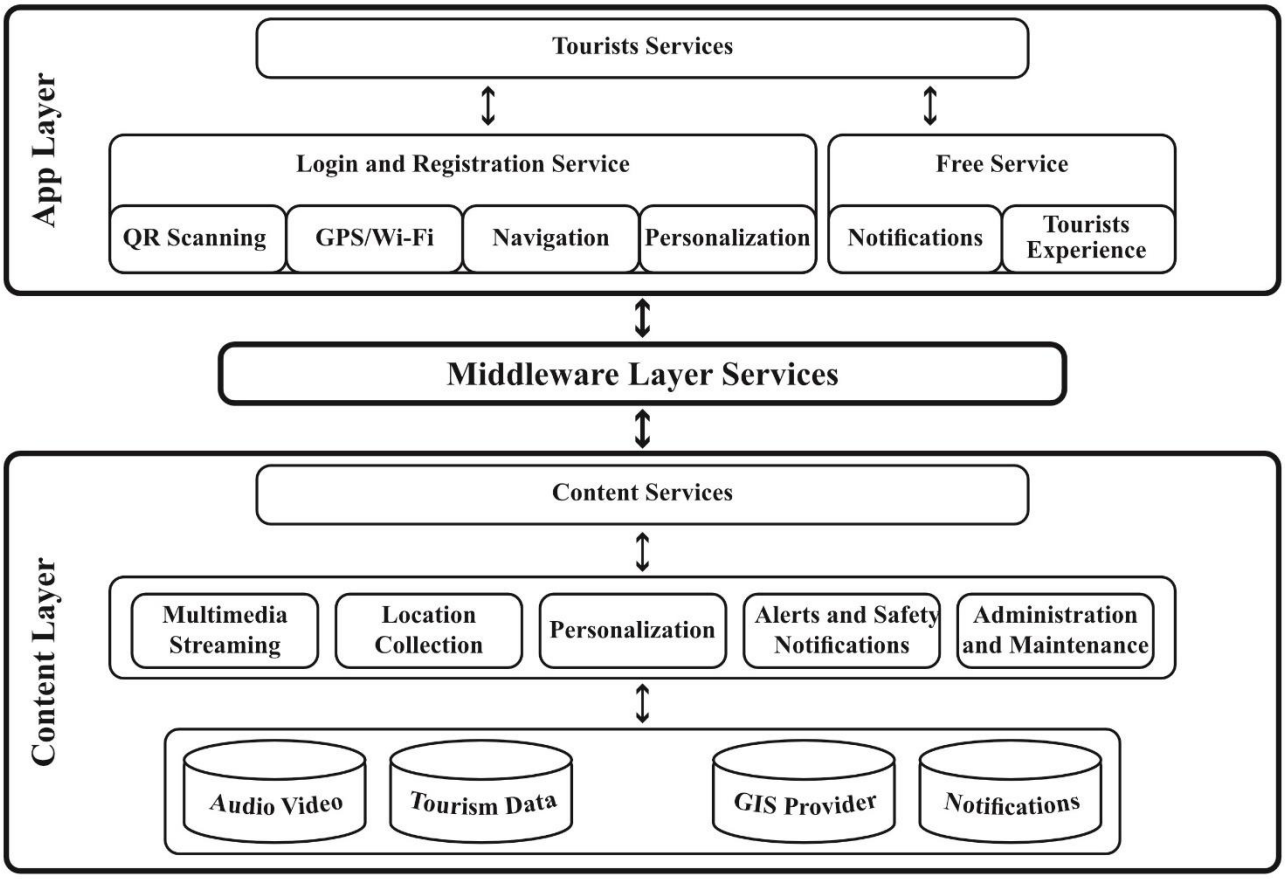

Fig. 1: System components

3.5. The system architectural services

To get the utmost of the system services, the system designers assume users are already registered with the system and provided their personal information as shown in Fig. 2 System Functions and Services. Guest users are limited only to three services which are: Notifications, Connectivity, and Experiences. The system services are integrated and combined together to ease system use and make menus appearance more attractive, and this task will be performed by the app designers. When designing the app, minimizing user action when keying in data to the system (MacKenzie, 2002) will be a priority and maintaining users privacy is another priority.

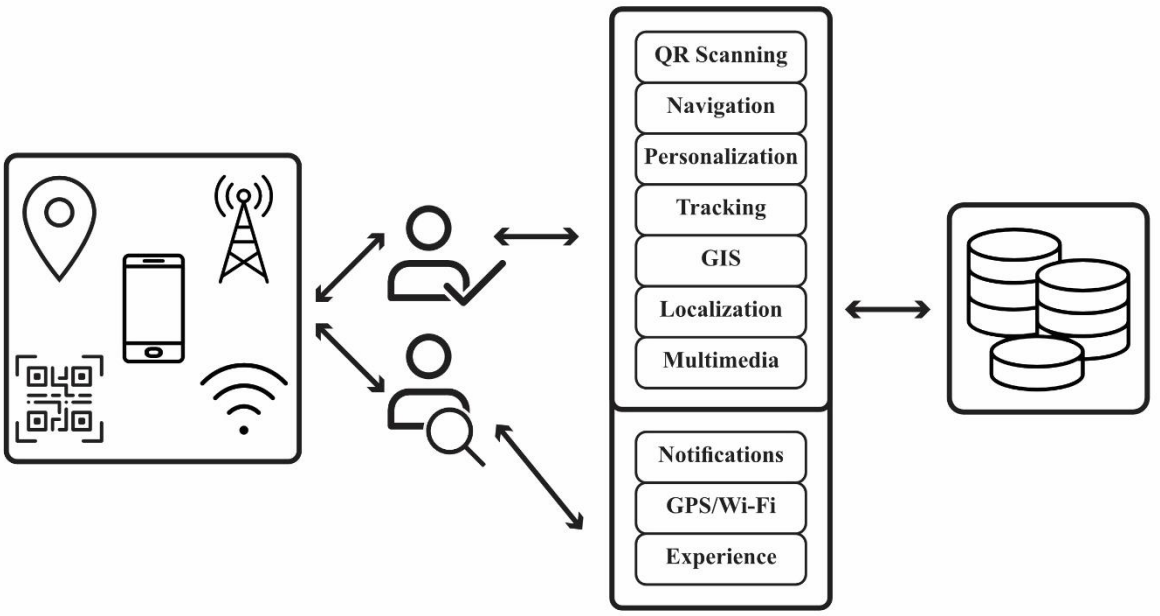

Fig. 2: System functions and services

System architecture is composed of different components to support the intended system services. It is recommended to use the Grouping Components Methodology (Meier et al., 2008) when designing mobile apps, the designers' main concern is to group the system components into areas of interests and then focuses on the interaction between the components to get the app works friendly.

The application (app) should be available on Google play once it gets approved by the official tourism authorities and should be ready for installation on tourists' mobile phone devices, it contains the main Tourism services a tourist needs like smart tourist guide audio-video services, navigations, localization, personalization, emergency notifications, finding best offers and bargains, find the nearby auctions, festivals, activities and events. All of these services are supported by the existing smartphone device capabilities, existing databases, tourists experience, service provider supports, content provider help and the smart integration of the system algorithms.

The system is designed to operate on Android devices in the first phase, other platforms will be included in future developments (Patil and Sakore, 2014). Scanning the QR tagging codes helps in activating the smart Tourism Guide Services either by watching the video streaming, hearing the stored audio files or get textual information (Böhm and Ruthardt, 2014). The GPS helps in localization, location identification, get the right directions to places and it allows the users to benefit from the emergency notifications. Upon location determination, it is possible to get notifications about the nearby activities and entertainments in addition to facilities like hotels and restaurants.

3.6. Algorithm Description

The systems work as follow:

Start
Initialize / Enable the Internet connection (Mobile Data or Wi-Fi)*
/ Enable the GPS connection*
*/*Enable the QR-Code reader*
*/*perform the Registration process (Optional)*
If not Registered user / Guest users have limited access*
If like to register/ Create credentials*
*Assign login ID /*Assign username*
Assign password / Create password*
Login as Authentic Register user
Else
*Login as Guest /*not registered user and want to login as Guest*
End-if
Else
Login as Authentic Registered user
End-if
If Authentic Registered user / Full STS services will be provided to a registered user*
Can get full system services

Can get tourist guide (audio, video and text formats)
Can get and provide feedback services
Can get GPS services
Can Navigate
Can personalize services
Can do localization
End-if
Can receive Notifications
Can get only textual tourist guide in text format
Can provide feedback and user experience
End

3.7. The system strengths and weaknesses of the system

The system was built using the CBA architecture model which in turn gives flexibility and expandability features for future amendments. Moreover, the adoption and utilizing of the smart capabilities of smartphones like GPS, LBS, navigation, group communication, NFC, QR Code reading and video streaming added extra features to the smart tourism system. Another great feature of the system lies in its ability to act as a smart multi-lingual spoken tourism guide. On the other hand, the success of the system totally depends on the assumption that each tourist has a smartphone device and an uninterruptable high-speed Internet connection which is considered to be the major threat facing the system implementation.

4. Conclusion and future work

The research project aims to provide a one-stop tourism service center using mobile apps that are based on modern ICT technologies. The researcher builds the proposed Architecture to allow flexible adding of more services without affecting the system design. The use of the Component-Based-Architecture approach along with the separation between the three layers of services shown in Fig. 1, which gives the system flexibility and expandability features. This is obvious from the type of provided services by the app; the app could help tourism authorities, agencies and tourists to facilitate easy arriving, touring, navigation and get notified for any emergency or unarranged event at any time. The system represents a framework model that is not limited to tourism, but it can be used for other services through performing some minor modifications and tolerating the required user interface, for instance, it could be adopted by city councils, municipalities, theaters, universities, ministries, schools or even by commuters during their travels. The researchers believe that the proposed model can provide a variety of tourism and other entertainment services. The model might be extended to support a wider scope of services that tourists need. In the future many other smart services can be added to the system, like smart object sensing and recognition, services rating, tourist crowded estimation, hotel booking, ticket buying, restaurant reservations, rent car services and many others.

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Compliance with ethical standards

Conflict of interest

The authors declare that they have no conflict of interest.

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